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D. O'BRIEN

THEORIES OF WEIGHT
IN THE ANCIENT WORLD

II

THEORIES OF WEIGHT IN THE ANCIENT WORLD

*Four Essays on Democritus, Plato and Aristotle
A Study in the Development of Ideas*

VOLUME TWO

PLATO WEIGHT AND SENSATION

The Two Theories of the 'Timaeus'

BY

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VOLUME ONE
DEMOCRITUS
WEIGHT AND SIZE
An Exercise in the Reconstruction of Early Greek Philosophy

VOLUME THREE
ARISTOTLE
WEIGHT AND MOVEMENT
'De caelo' Book Four: A Reconstruction of Aristotle's Theory

VOLUME FOUR
ARISTOTLE
WEIGHT AND MOVEMENT
'De caelo' Book Four: An Interpretation of Aristotle's Theory

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PART ONE

WEIGHT AND DIRECTION

CHAPTER ONE

THE ANALYSIS OF DIRECTION

§ 1. INTRODUCTION

(i)

Plato analyses weight in two different passages of the *Timaeus*, briefly in his account of the elemental triangles (56A6ff.), and in more detail in his account of human sensation and perception (62C3-63E8).

In the earlier passage, weight is said to be determined by the number of triangles which make up a body. In the later passage, the explanation of weight is tied to an elaborate account of differences of direction in the cosmos. Purely for convenience, I have entitled my analysis of the earlier theory 'Weight and number', and my analysis of the later theory 'Weight and direction'.

Two theories, or only one? Aristotle takes the earlier passage as Plato's 'definition' of weight.¹ Modern scholars concentrate on the later passage; if they refer at all to the earlier theory, they claim it is merely a 'passing' or a 'chance remark', not to be taken seriously, and in any case inconsistent with what Plato says later.²

The reader who has glanced at my table of contents will already know that I believe the 'two' theories to be reconcilable.³ More than that: the 'two' theories are, I believe, complementary features in a single but complex conception of weight, which Plato worked out largely in reaction to Democritus, and which contributed significantly to the formation of Aristotle's ideas.

How it is that modern scholars should have so radically misunderstood Plato's theory, and on what grounds we can reinterpret the theory in the way I have stated, are the two subjects which I mean to study in this volume.

(ii)

The first part of my essay aims at a literal understanding of the details of the text, in the later of the two passages of the *Timaeus*. For unless we

¹ *De caelo* iii 1, 299b31-300a7 (διώρισται, a1); iv 2, 308b3ff. (διωρισμένων, b12; cf. b1 and 29).

² The quotations are from Cherniss: see p. 79 below.

³ See esp. ch. VIII § 3, pp. 153ff. below.

have an exact grasp of what Plato says, and of what he does not say, in his longer and later analysis of weight and of direction, we can have no hope, I believe, of seeing just how it is that Plato intends to reconcile the later with the earlier theory:—the subject of the second part of my essay.

In part three I attempt to trace the criticisms which Aristotle and which Theophrastus make of the theory. This is doubly important. Plato's theory has, I believe, been misunderstood by modern scholars largely because, as with Democritus, it has been approached from the standpoint of Aristotle's criticism of the theory, with the result that features from the attempted refutation of Plato by Aristotle and by Theophrastus have been allowed to encroach upon Plato's own exposition of his ideas. As with Democritus, therefore, we need to be able to read Plato's theory with the eyes of Aristotle and of Theophrastus, if only in order to be able to avoid reading into the text of the *Timaeus* those features which in fact derive from the *De caelo* and the *De sensibus*.

An understanding of the criticisms which Aristotle and Theophrastus make of Plato is no less important for an understanding of Aristotle himself. Unless we understand the considerations which Aristotle and Theophrastus set in opposition to Plato's theory, we shall be unable to discern those features in Aristotle's own thinking which he owed to Plato, when, in my third and fourth volumes, we come to examine the theory of weight and of movement which Aristotle put forward, seemingly with so little regard for Plato, in the *Physics* and in the *De caelo*.

(iii)

A synopsis of the main stages in the exposition of the 'later' theory (62C3-E8) may be useful.

Plato tells us that an understanding of 'up' and 'down' is necessary for an understanding of 'heavy' and 'light' (62C3-4). The passage which follows can be divided between an analysis of direction (62C5-63A6) and an analysis of weight (63A6-E8).

The analysis of direction begins with an attack on the way people commonly think of movement up and down (62C5-8). Plato follows this with his own definition of centre and circumference (62C8-D4), which he offers as a correction to the popular usage (62D4-10). This definition is applied to a stationary, central body, which in this context is obviously intended to represent the earth (62D10-63A2). Plato tells us that someone who walks around the surface of the central body would call the same part of the central body at different times 'up' and 'down' (63A2-4). This inconsistency is intended to show up the inadequacy in the way that people commonly talk of 'up' and 'down' in relation to 'the whole' (63A4-6).

The analysis of weight, Plato tells us, will show how we have come to use 'up' and 'down' in the way we do (63A6-B1). We have to imagine an observer, standing at the circumference of the universe, and weighing different quantities of fire (63B2-C5), in the way that we, standing on the surface of the earth, weigh different quantities of earth and of things like earth (63C5-D4). Plato compares these two activities (63D4-E3), in order to provide a final, synoptic definition for the meaning of 'up' and 'down', 'heavy' and 'light', as measured at the centre and at the circumference of the universe (63E3-8).⁴

§ 2. THE COMMON ERROR

(i)

Plato begins the later passage by relating 'heavy' and 'light' to the distinction between 'up' and 'down', or 'above' and 'below'. He writes, 62C3-4: βαρὺ δὲ καὶ κοῦφον μετὰ τῆς τοῦ κάτω φύσεως ἄνω τε λεγομένης ἐξεταζόμενον ἂν δηλωθεῖη σαφέστατα. "'Heavy'" and "'light'" can be explained most clearly if they are scrutinised in conjunction with the nature that is spoken of as "'above'" and "'below'".

This in itself, as I noted in the concluding chapter of my first essay, marks a significant shift from the presuppositions of earlier thinkers, including Democritus. Theophrastus and Plutarch help us to see that differences of heavy and light were, for the Presocratics, determined as much by differences of density, and not primarily by movements 'up' and 'down'.⁵

(ii)

The assumption—the common error—which Plato sets out to correct is that there are two places which 'divide the whole between them': 'below', to which everything travels which has any body or 'bulk', and 'above', to which things travel only involuntarily, 62C5-8: φύσει γὰρ δὴ τινὰς τόπους δύο εἶναι διειληφότας διχῇ τὸ πᾶν ἐναντίους, τὸν μὲν κάτω, πρὸς ὃν φέρεται πάνθ' ὅσα τινὰ ὄγκον σώματος ἔχει, τὸν δὲ ἄνω, πρὸς ὃν ἀκουσίως ἔρχεται πᾶν, οὐκ ὀρθὸν οὐδαμῇ νομίζειν.

Since Plato later speaks of this same idea as 'the way in which we have grown accustomed to thinking' (εἰθίσμεθα, 63A6-8), he must be intending to attack a popular idea, without limiting himself to any particular theory. It is significant nonetheless that the circumstance which Plato en-

⁴ A translation of the whole passage, 62C3ff., is given at the end of my analysis, pp. 41-4 below.

⁵ Vol. i pp. 364ff.

visages is sufficiently similar to the behaviour of atoms in Democritus' cosmic *dine* for Simplicius to feel justified in using the atomic theory to illustrate Plato's point.⁶

Simplicius' own complaint against the Atomists is similar to the criticism which Plato makes. Simplicius' point, as I have shown in the earlier part of this study, is that on the atomic theory heaviness alone exists, and that lightness, or light things, only 'appear' to be so, since for the Atomists there can be no natural movement in an upward direction.⁷

Plato's implied distinction between 'voluntary' and 'involuntary' movement, Simplicius sees therefore as answering to the Aristotelean distinction between natural movement and movement that is contrary to nature. From this point of view, the movement which Plato sees as 'involuntary', Simplicius sees as an 'appearance' only. Simplicius believes that there should exist bodies which move upwards 'voluntarily', 'by nature': the atoms only 'appear' to do so.

Simplicius' criticism is in turn essentially the same as the criticism which Aristotle makes frequently of earlier theories, including that of Democritus: namely that if all things are made from a single material principle, which is one of the ways in which Aristotle classifies the atomic philosophy, then everything will travel downwards, and there will be nothing that is light absolutely or that travels upwards by nature.⁸

On one version of such a theory, Aristotle tells us, a version which I shall argue later is the same as, or at least includes, that of Democritus, there are two ways by which upward movement can be accounted for.

1. Things 'fall behind': ὑστερίζον.
2. They are 'squeezed outwards': ἐκθλιβόμενον.⁹

In the *first* case, Simplicius takes Aristotle's point to be that if one thing moves downwards more slowly than another then it may appear to move upwards, but the appearance is illusory. This then would be essentially the same as, or at least would be included within, Simplicius' own point, that light things, on the atomic theory, only 'appear' to be so.¹⁰

⁶ *De caelo* 269. 4-14, quoted and discussed, vol. i pp. 161-6.

⁷ *De caelo* 569. 5-9: see vol. i pp. 154-61.

⁸ Vol. i, esp. pp. 11-15 and 20. I present here only a very simplified form of Aristotle's criticism. The necessary elaboration and refinements may be found in the relevant chapters of my first and of my third essay.

⁹ *De caelo* iv 2, 310a7-11. I discuss in my third volume the attribution of this theory, where weight is defined by 'largeness and smallness'. For the Atomists' use of ἐκθλιψις, see vol. i p. 153 n. 3.

¹⁰ Simplicius' interpretation of ὑστερίζον, *De caelo* 693. 15-18, I shall argue in my third volume is a trifle too elaborate.

In the *second* case, the complaint intended by Aristotle will be that if things are 'squeezed out' then they move upwards 'by force' and not 'by nature'. This therefore is essentially the same as the criticism which Plato makes, except that Plato's expression of the point betrays a touch of animism which, whether intended by Plato ironically or not, is probably a fair reflection of popular ideas of the time: things which move upwards do so 'against their own wishes' (*ἀκουσῶς*).

(iii)

I have dwelt on the similarity between the criticism with which Plato opens his account of heavy and light, and later criticisms which Aristotle and Simplicius direct against Democritus, only partly in order to suggest that Plato may intend to include Democritus within the range of his more general criticism.

For if Plato is right in saying that the circumstance which he describes is the way in which 'we have become accustomed to thinking' (*cf.* 63A6-8), then Democritus will simply have been following a conventional distinction in so far as, in his cosmic *dine*, smaller and lighter atoms are 'squeezed out' by larger and heavier ones, and may therefore be imagined as rising 'involuntarily'.

And in that case, it will be as pertinent to argue positively and specifically that Democritus is included in Plato's preliminary criticism, as it would be to argue negatively and more generally that he is unlikely to have been excluded.¹¹

What is more important is that the similarity between Plato's preliminary criticism and the criticism in Simplicius and in Aristotle should not mislead us into thinking that the point of departure of the three criticisms is the same.

For Plato's own theory will be *neither* that everything is drawn invariably downwards, i.e. towards the centre, and moves upwards only 'involuntarily', as (according to Simplicius) in the *dine* of Democritus, *nor*

¹¹ In writing in this way, I hope that I have avoided the need for making a choice between *either* Democritus *or* a popular view. The former interpretation is adopted by Eduard Zeller, *Die Philosophie der Griechen* Teil I Abteilung 2 6th edn by W. Nestle (Leipzig, 1920) (= ZN) 1087 n. 6, emphasised in *AGPh* 5 (1892) 445-6; the latter interpretation is adopted by Nestle, ZN 1087 n. 6, where further references to modern authors are given. For my own view, see further pp. 392-3 below.

Even in taking Democritus as possibly included in the target of Plato's criticism, I do not mean to imply that Democritus himself would necessarily have spoken of smaller atoms as rising 'involuntarily', only that this would be a possible transference of ideas from the notion of force implicit in *ἐκθλιψις*. This transference may conceivably have been effected by Democritus himself, but it could equally well have been added by Plato—if Plato does in fact intend to include Democritus' theory as part of a popular way of thinking. On a similar point (the void as 'voluntary'), see vol. I p. 168 n. 1.

the converse idea, that some things move downwards 'by nature', while other things 'by nature' move upwards, as in Aristotle's theory.

Plato's belief, as we shall see, is that fire and earth travel 'voluntarily' towards their parent body, but that in doing so either element is moving 'downwards'. Thus Plato agrees in effect with Aristotle that fire and earth move respectively towards the circumference and towards the centre of the universe 'voluntarily', or as Aristotle would say 'by nature'. But Plato does not therefore mean to challenge, as Aristotle does, the assumption that the only 'voluntary' movement is movement 'downwards'. Plato means in fact to correct only that feature of the popular assumption which Aristotle, with one modification, will be happy to accept, namely that "'up" and "down" divide the whole between them'. For Plato believes that in moving 'voluntarily' towards its parent body, i.e. towards the circumference, fire, no less than earth, is moving 'downwards'.

The implications of this agreement and disagreement, between Plato and Aristotle and between Plato and 'Democritus', I shall try to spell out later.¹² For the moment I note simply that Plato's preliminary criticism, when it has been fully explored, will serve to mark the distance between Plato's own theory and earlier theories, including that of Democritus, and at the same time the difference between Plato's own theory and that which we shall find in Aristotle.

(iv)

This ambivalence in Plato's opening criticism is essential to my enquiry. For as I have already indicated, my thesis will be that Plato's conception of heavy and light occupies a significant position, midway between that of Democritus and that of Aristotle, and that Aristotle's own theory can be properly understood, from an historical point of view, only as a more thoroughgoing and a more rigorous attempt to oppose the theory of Democritus on lines that had already been laid down by Plato.

For this analysis to succeed, it is as essential to appreciate the difference between Plato's ideas and those of Aristotle, as it is to appreciate the force of the distinction which Plato himself saw between his own ideas and those of his predecessors, including Democritus.

The difficulty of establishing precisely the latter distinction has perhaps been inevitable, given the necessity of reconstructing Democritus' theory solely from secondary evidence.

But the former distinction, between Plato's theory and that of Aristotle, has, I believe, also eluded scholars hitherto, despite the fact that the

¹² Pp. 188-91 and 387ff. below.

relevant texts, both of Plato and of Aristotle, have survived, in a complete, or at least in an extensive form.¹³

The reason for this, I shall try to show, lies partly in the sheer intricacy of the language and the ideas of the *Timaeus*, and partly, as with Democritus, in calculating the kind of conceptions that determined people's ideas before the contours of philosophical thinking had been reshaped, for good or ill, by agreement with, or opposition to, Aristotle.

These two factors, I shall argue, have conspired to conceal from modern scholars the true nature of Plato's theory, because Plato's own preoccupations have left certain ambiguities, crannies or crevices as it were, in the exposition of his theory, which modern scholars either fail to notice, or unconsciously fill in with presuppositions that are derived from, or are at least heavily influenced by, their knowledge of Aristotle.

Thus Taylor, I shall argue, unconsciously incorporates Aristotelean assumptions into his interpretation of Plato's theory, in much the same way that Burnet, as I hope I have shown in my earlier study, incorporates Aristotelean assumptions into his reconstruction of Democritus.¹⁴

In either case, the individuality of the earlier theory is hidden from sight beneath the sheer force and familiarity of Aristotle's ideas, although in either case, paradoxically, it is Aristotle, rightly understood, who provides invaluable information for the reconstruction, or the confirmation, of the earlier theory, even when, as here with Plato, the original text has survived in its entirety.

§ 3. CENTRE AND CIRCUMFERENCE

Plato intends to combat the 'common error' by maintaining that in a spherical universe centre and circumference provide the only true reference for position, or for direction, and that neither centre nor circumference can properly be described as 'up' or as 'down'.

He begins by defining the centre and the circumference with reference to each other.

1. The circumference, or the 'extremities', are equidistant from the centre, and are all therefore equally 'extreme'.
2. Likewise, the centre is equidistant from the circumference, and is therefore opposite to every point on the circumference without distinction.

¹³ In adding the qualification I have in mind the theory of aether as weightless, which may have found a place in Aristotle's lost treatise *On philosophy*.

¹⁴ Taylor's interpretation of Plato, ch. III § 1, pp. 45-50 below. Burnet's interpretation of Democritus, vol. i pp. 153-4 and 347-64.

He writes, 62C8-D4: τοῦ γὰρ παντὸς οὐρανοῦ σφαιροειδοῦς ὄντος, ὅσα μὲν ἀφεσπῶτα ἴσον τοῦ μέσου γέγονεν ἔσχατα, ὁμοίως αὐτὰ χρῆ ἔσχατα πεφυκέναι, τὸ δὲ μέσον τὰ αὐτὰ μέτρα τῶν ἐσχάτων ἀφεσπῆχός ἐν τῷ καταντικρὺ νομίζειν δεῖ πάντων εἶναι.

Since this is the nature of the cosmos, neither the centre nor any part of the circumference, Plato argues, can properly be spoken of as ‘up’ or ‘down’, ‘above’ or ‘below’. He writes, 62D4-10: τοῦ δὲ κόσμου ταύτη πεφυκότος, τί τῶν εἰρημένων ἄνω τις ἢ κάτω τιθέμενος οὐκ ἐν δίχῃ δόξει τὸ μηδὲν προσῆκον ὄνομα λέγειν; ὁ μὲν γὰρ μέσος ἐν αὐτῷ τόπος οὔτε κάτω πεφυκώς οὔτε ἄνω λέγεσθαι δίκαιος, ἀλλ’ αὐτὸ ἐν μέσῳ· ὁ δὲ πέριξ οὔτε δὴ μέσος οὔτ’ ἔχων διάφορον αὐτοῦ μέρος ἕτερον θατέρου μᾶλλον πρὸς τὸ μέσον ἢ τι τῶν καταντικρὺ.

Straightforward though they may seem at first sight, we need to consider carefully these preliminary moves in Plato’s argument, if we are to follow precisely Plato’s sequence of thought in his analysis of position and direction, and more particularly if we are not to be thrown off course when we enter the more troubled waters where Plato coordinates the distinction between up and down with the distinction between heavy and light.

For the moment, in this present section, I content myself with seeking to establish the precise meaning of the final sentence which I have quoted. This sentence has, I believe, been persistently misunderstood, and mistranslated, in part because of its internal complexities, but also because it has not been correctly related to the sequence of Plato’s argument, and more particularly to the form of Plato’s opening definition of the nature of centre and circumference.

(i)

In the last sentence which I quoted, Taylor took ἢ to mean ‘or’, and translated:

‘... and the circumference again is, of course, not in the middle, nor does any part of it differ in any way from any other relatively to the middle or to anything “opposite” itself.’

He adds by way of explanation:

‘In effect, though not *totidem verbis* this amounts to saying that the only point that can be distinctively called “opposite” to a point on the circumference is the centre, and this is equally “opposite” to all points on the circumference.’¹⁵

¹⁵ Alfred E. Taylor, *A commentary on Plato’s ‘Timaeus’* (henceforward *Commentary*) (Oxford, 1928) 437. Cf. *Plato: ‘Timaeus’ and ‘Critias’, translated into English* (London, 1929) 64.

Taylor's intention is apparently to treat ἡ epexegetically. But not only does this interpretation make ἡ τι τῶν καταντικρῷ (understood apparently as ἡ <πρός> τι τῶν καταντικρῷ) an otiose repetition of πρὸς τὸ μέσον; there is the added confusion that though Plato speaks of 'things opposite', in the plural, he has to mean, in fact, only the middle.

Taylor was, however, on the right track, I believe, in looking back for an explanation of the sentence to Plato's initial pair of definitions, where the centre had been defined as 'opposite to all points on the circumference'. Taylor's error, I shall suggest, lay in looking to the definition of the centre, and not to the definition of the circumference.

(ii)

Cornford, however, lost even this potential advantage in Taylor's interpretation, although he surmounted the more obvious hurdle, in seeing that ἡ means not 'or' but 'than'. This at least is the construction that appears to be implied by his translation:

'... while the circumference is not, of course, central, nor is there any difference, distinguishing one part of it from another with reference to the centre, which does not belong equally to some part on the opposite side.'

He adds:

'No part has the property of "being above (or below) the centre", or has any better right to that description than a point on the opposite side. This is the counterpart of the statement above, that the centre cannot be called "above" the "lower" hemisphere or "below" the "upper" hemisphere.'¹⁶

The error in this, it seems to me, lies in taking μάλλον πρὸς τὸ μέσον, as Taylor had done, to mean simply 'relatively to' or 'with reference to' the centre, and so in taking Plato's point to be simply that no one part of the circumference is 'above or below the centre'.

This deprives μάλλον of any comparative force, with the result that, in Cornford's translation, ἡ apparently attaches not directly to μάλλον, which must be the meaning of the Greek, but in some way to διάφορον. Hence the uneasy paraphrase: 'nor is there any difference ... which does not belong equally ...'.¹⁷

As it is, the more natural meaning of μάλλον πρὸς τὸ μέσον, it seems to me, is that no one part of the circumference should be 'more closely related to the centre'. Plato's point I take to be that no part of the circumference

¹⁶ Francis M. Cornford, *Plato's cosmology, the 'Timaeus' of Plato translated with a running commentary* (henceforward *Cosmology*) (London and New York, 1937) 262 and 262 n. 3.

¹⁷ Cornford states plainly in his note, *Cosmology* 262 n. 3, that he takes ἡ with μάλλον, but this is not at all clear in the translation he has given.

can be reckoned as different from any other, and therefore as being ‘up’ or ‘down’, *because* no part of the circumference is ‘*more nearly* central *than* any of the parts which are opposite to it’.

(iii)

For the point to remember is that Plato had defined the circumference, or the ‘extremities’, with reference to the centre, 62D1-2:

‘Whatever parts of the whole, by standing back an equal distance from the centre, have been constituted as extremities, must by nature be all equally and in the same sense extreme.’

The danger, as it were, which Plato seeks to counter at this point is not therefore, as Cornford supposes, simply and directly that one part of the circumference is reckoned as being above the centre, and that another part is reckoned as being below it.

It is true, the goal of Plato’s remark will be to deny that any ‘place’ in the universe can truly be reckoned as ‘up’ or ‘down’ (*cf.* 63A4-6). But Cornford has short-circuited the means by which Plato arrives at this goal.

The point which in this sentence Plato seeks explicitly to deny is that any one part of the circumference should be *closer* to the centre than any of the parts which are opposite to it. For *this* is the point which would directly offend Plato’s initial definition, that the extremities are equidistant from the centre, and are therefore all equally and in the same sense extreme.

(iv)

The reason why this point has not been appreciated, and why the sentence has been misunderstood, stems, I think, from the fact that in this sentence Plato offers in effect two comparisons.

1. Plato first states simply that no one part of the circumference is ‘different from any other’: διάφορον ... ἕτερον θατέρου.

2. The intricacy of the sentence lies in the fact that the respect in which difference is denied, ‘proximity to the centre’, διάφορον ... μᾶλλον πρὸς τὸ μέσον, is then extended to furnish a second comparison. No part is related to the centre ‘more closely than any of the parts of the circumference that are opposite to it’: μᾶλλον ... ἢ τι τῶν καταντικρύ.

Misinterpretations of Plato’s sentence have arisen from the failure to distinguish, and to keep distinct, these two comparisons.

Taylor's interpretation obliterates the *second* comparison, by making it no more than a repetition of the *first*. For Taylor's interpretation is essentially that:

'No part of the circumference differs from any other in relation to the middle or to any point' namely the middle 'which is opposite to the circumference.'

Cornford we might expect to distinguish the *second* comparison from the *first*, since he rightly takes ἤ to mean 'than'. But in fact Cornford's interpretation robs the second comparison of any independence of meaning no less effectively than does that of Taylor. For the essence of Cornford's interpretation is that:

'No point on the circumference is different from any other in relation to the centre' by being above or below the centre 'any more than any of the points which are opposite to it' and which can with equal right be reckoned as above or below the centre.

By advancing at once to the goal of Plato's sentence, Cornford has at his disposal only a single term of comparison: that by which something is up or down, above or below. This distinction therefore Cornford has to apply *both* to the part of the circumference which is 'other' than the first (ἕτερον θατέρου) and *equally* to the part which is 'opposite' to the first (ἢ τι τῶν καταντικρύ).

On Cornford's interpretation there is therefore no distinction of substance between the first and the second comparison. In *either* case, on Cornford's interpretation, Plato can be denying only that any one point should be reckoned as 'up', because it is 'above' the centre, and as distinct therefore from any other point which might be reckoned as 'down', because it is 'below' the centre.

(v)

But Plato's form of expression requires there to be two comparisons, which should be distinguishable:

1. The *first* comparison is expressed in διάφορον ... ἕτερον θατέρου.
2. The *second* comparison is expressed by μᾶλλον ... ἢ τι τῶν καταντικρύ.

These two comparisons have a distinct but complementary meaning if they are taken in the way that I have proposed. The implied denial of position or direction attaches primarily to the *first* comparison, which is then explained, or justified, by the *second* form of comparison. Plato's point is that no part of the circumference will be different from any other,

and by implication cannot therefore be distinguished as ‘up’ or ‘down’ (the *first* comparison), because it cannot be any closer to the centre than any one of the parts that are opposite to it (the *second* comparison).

If we simplify Plato’s expression slightly, so as to have only one point ‘opposite’ to the first, and so take A, B and C as points on the circumference of a sphere, where A and B are opposite ends of a diameter, and C is any point other than A, then in Plato’s sentence the denial of a certain relation between A and B is offered as justification for the denial of a certain other relation between A and C: A cannot be reckoned as being different from any other point, C, and cannot be reckoned therefore as ‘up’ or ‘down’, *because* it is no closer to the centre than the point B which is opposite to it.

The point to appreciate is that Plato does not deny simply, or even primarily, that points which are opposite each other can be distinguished as up or down. His point is that *no* two points on the circumference can be distinguished as up or down *because* no point on the circumference can be any closer to the centre than the part which is opposite it—or, to return to Plato’s own plural expression, ‘than any of the parts that are opposite’.

For those who prefer to grasp these points visually, I offer a diagram (placed at the end of this volume).

A is no different from C (οὐτ’ ἔχων διάφορον αὐτοῦ μέρος ἕτερον θατέρου), and cannot therefore be distinguished as ‘up’ or ‘down’, because it is no closer to the centre than any of the points B that are opposite to it (οὐτ’ ἔχων ... μέρος ... μᾶλλον πρὸς τὸ μέσον ἢ τι τῶν καταντικρύ). The dotted line indicates what is denied by the second comparison.¹⁸

(vi)

This interpretation explains the seemingly all too obvious remark that ‘the circumference is not central’, a banality which both Cornford and Taylor seek to mitigate, or to mask, by translating δῆ as ‘of course’.

¹⁸ I see no reason for the plural other than a natural inclination to pluralise B so as to exclude the possibility that A might be closer to the centre than any one of a number of possible points on that part of the circumference which is ‘opposite’ to A. I retain the slight anomaly whereby the B’s are included in the C’s: no part of the circumference (A) is different from *any* other (C) by being closer to the centre than those particular parts (B) opposite to the first.

It follows from my analysis that ‘opposite’ (καταντικρύ) has two different references in Plato’s argument. It is first used as a description of the relation of the middle to the circumference: ‘the centre is “opposite” to all the extremities’ (62D3-4). It is then used as a description of the relation between one part of the circumference and another: ‘no part of the circumference is closer to the centre than any of the parts that are “opposite” to the first’ (62D8-10). Taylor’s error (p. 10 above) is in effect to give the word a single reference, and so to reduce the *second* reference to the *first*, a much too mechanical approach to the subtlety and the fluidity of Plato’s use of words in the *Timaeus*.

It is true that part of the reason for this initial phrase lies, I think, simply in Plato's desire to make οὔτε ... οὔτε ... in his account of the circumference repeat the form of οὔτε κάτω ... οὔτε ἄνω ... in his account of the centre immediately preceding. Although the meaning of either expression is not the same, the verbal repetition nonetheless helps to heighten the sense of archaic and hieratic elaboration which Plato aims at in the *Timaeus*.

At the same time, Plato's opening phrase gains, I think, in point if we take his meaning to be not simply that 'the circumference is neither central, nor is any part *differently related to the centre* from any of the parts which are opposite to it', but that 'the circumference is *neither central nor* is any part *more nearly central* than the part which is opposite to it'.

On this interpretation, the addition of the particle δὴ will no doubt be ironical, as Cornford and Taylor perhaps intend it to be. But the sequence of thought will no longer be as fatuous and banal as it is if we fail to appreciate the precise force of the double comparison in the second half of the sentence.

I translate therefore, 62D8-10:

'The circumference can hardly be central, nor does it have any part of itself different from any other (*sc.* and so capable of being distinguished as "up" or "down") in being closer to the centre than any one of the parts that are opposite to it.'

By this means we do of course arrive at the same conclusion as Taylor and Cornford, the conclusion which is imposed by the drift of Plato's argument as a whole: that no 'place' in the universe can properly be reckoned as 'up' or as 'down' (*cf.* 63A4-6). But the precise route by which Plato has arrived at this conclusion is not without significance for the furtherance of his argument, as we shall now see.¹⁹

§ 4. THE CENTRAL BODY

In the sentences which follow, Plato argues that a solid body placed at the centre of the universe could not be drawn to any one part of the circumference more than to any other, 'because of the sameness of the extremities in every direction'. He writes, 62D10-63A2: τοῦ δὲ (*sc.* κόσμου) ὁμοίως πάντῃ πεφυκότος ποῖά τις ἐπιφέρων ὀνόματα αὐτῷ ἐναντία καὶ πῇ καλῶς ἂν ἡγοῖτο λέγειν; εἰ γάρ τι καὶ στερεὸν εἴη κατὰ μέσον τοῦ παντὸς ἰσοπαλές, εἰς οὐδὲν ἂν ποτε τῶν ἐσχάτων ἐνεχθείη διὰ τὴν πάντῃ ὁμοιότητα αὐτῶν.

¹⁹ For earlier interpretations of this passage, other than those of Taylor and Cornford, and for minor points in my translation including my translation of δὴ, see Note 1, pp. 319-24 below.

(i)

For all we can tell, the text of the *Timaeus* may be teeming with allusions to earlier Greek philosophical writings. But the elaborate, even incantatory, style of the *Timaeus* would have made explicit quotation, and even the naming, of earlier thinkers impossibly cumbersome, and as a result it is only exceptionally that we are now able to recognise a quotation or allusion which to a reader of the time would no doubt have been obvious.

The two sentences quoted above are one of the exceptions. For when Plato writes that a body 'poised at the centre' of a spherical universe would not be drawn to any one point on the circumference any more than to any other, he is in effect repeating an argument which he had used in the *Phaedo* to explain the stability of the earth, and which in the second book of the *De caelo* Aristotle tells us had been employed by Anaximander for the same purpose.²⁰

The rival arguments which Aristotle quotes at length in the *De caelo*, and which Plato alludes to briefly in the *Phaedo*, rest on the assumption that the earth will 'fall' unless it is held in place by some extraneous force, whether by water, or by air trapped beneath the earth, or by the force of rotation which surrounds the earth.²¹ Viewed in this context, the point of Plato's argument, or of Anaximander's argument, is that the earth will 'fall' only if there is a specific direction for it to fall in. Plato's idea will be that the central body cannot travel to any one part of the circumference, more than to any other, because there would be, as it were, nothing to choose between them.

The point which is relevant to this argument is therefore precisely the point to which Plato has given emphasis in the sentence previously analysed (62D8-10): that no one part of the circumference can be any closer to the centre than any other.

Plato's thought is evidently that if it could be, then whichever part were closer would be able to draw the central body towards it.

(ii)

Plato underlines this intention by two verbal repetitions.

1. When he attributes the immobility of the central body to the 'sameness' of the extremities in every direction (63A1-2: διὰ τὴν πάντη ὁμοιότητα αὐτῶν), his expression picks up from the initial definition of

²⁰ Plato, *Phaedo* 108E4-109A7. Arist. *De caelo* ii 13, 295b10-296a23, cf. *Phys.* iv 8, 214b31-215a1. Aristotle has been thought to be mistaken in his attribution of this idea to Anaximander; I consider the question briefly in Note 2, pp. 325-6 below.

²¹ *De caelo* ii 13, 294a10-295b10.

the extremities as being 'all in the *same* sense extreme' (62D2: *ὁμοίως αὐτὰ χρὴ ἕσχατα πεφυκέναι*).

2. When he concludes that the central body is '*equally* balanced' (*ἰσοπαλές*, 63A1), his expression very likely looks back to the opening definition, where the extremities are '*equally* distanced' (*ἄφειστῶτα ἴσον*, 62D1) from the centre.

The precise force of this repetition of thought and expression is plain, only if we interpret correctly the intervening sentence, which Cornford and Taylor have bungled (62D8-10).

1. Plato's initial definition (62D1-2) states that the extremities are '*equally* distanced' from the centre, and are therefore 'all *alike*' extreme.

2. In the intervening sentence (62D8-10), Plato argues that 'no one part of the circumference is different from any other in being closer to the centre than whatever part is opposite to it'.

3. From this Plato concludes (62D12-63A2) that the central body cannot be drawn to any one part of the circumference more than to any other: the central body remains '*equally* poised', because of the '*likeness*' of the extremities.

§ 5. THE COSMIC TRAVELLER

So far, Plato has argued (62D10-63A2) that a body placed in the centre of a spherical universe can have no tendency to move to one part of the circumference more than to any other. For there is no way in which any part of the circumference can be meaningfully distinguished, as source of attraction as it were, from any other.

Plato now tells us that the body placed in the centre cannot itself properly be divided into 'up' and 'down'. For if someone were able to walk around the surface of this central body, then at different times he would call the same part of it 'up' and 'down'. Plato writes, 63A2-4: *ἀλλ' εἰ καὶ περὶ αὐτὸ πορεύοιτό τις ἐν κύκλῳ, πολλάκις ἂν στάς ἀντίπους ταύτῳ αὐτοῦ κάτω καὶ ἄνω προσείποι*.

(i)

The introduction of the 'cosmic traveller' makes plain what had already been implied by the tacit allusion to Anaximander.

At the beginning of his analysis, Plato had treated the centre successively as a point (*τοῦ μέσου*, 62D1-2) and as a place (*ὁ μέσος τόπος*, 62D6-7). In the argument repeated from Anaximander, we are asked to suppose that this place is occupied by a body (62D12-53A2: *εἰ γάρ τι καὶ*

στερεὸν εἴη ...). We are now further asked to imagine that someone could 'walk all the way round' this body 'in a circle' (63A2-4: ἀλλ' εἰ καὶ περὶ αὐτὸ πορεύοιτό τις ἐν κύκλῳ ...).

The implication is plainly that, for Plato as for Anaximander, the 'central body' is the earth, although at this stage in his analysis Plato avoids naming either of the elemental bodies that occupy the centre and the circumference (earth and fire respectively), since it is the nature of these bodies which will determine the account of weight that is to follow (63A6ff.).²²

(ii)

Despite its seeming simplicity, the precise content of Plato's argument at this point has been often misunderstood.

Thus one recent commentator takes the assertion of 'up' and 'down' to attach not to the central body itself, but to the observer: 'A man walking around such a body would be at one time called "above" and another time, "below"'.²³ But this is plainly at variance with Plato's text: αὐτοῦ at 63A3 clearly picks up from αὐτό at 63A2. The point is not that the cosmic traveller will call himself (or be called by others) 'up' and 'down' at different times, but that he will call the same part of the central body at different times 'up' and 'down'.

Even stranger is Archer-Hind's belief that the cosmic traveller is walking, not around the earth, but around the inner circumference of the heavens.²⁴ This is again excluded by Plato's text: περὶ αὐτό at 63A2 clearly picks up from τι ... στερεόν at 62D12.²⁵

Archer-Hind's reasoning is that if the cosmic traveller were walking round the earth, 'every point in it would always be κάτω in the vulgar sense'. Cornford appears to accept this conclusion, when he writes that:

²² The lack of explicit identification of the central body with the earth is taken by Taylor as proof that 'Timaeus' did not himself believe in a central earth: 'he speaks of this body as though he were merely imagining it', *Commentary* 437-8, cf. 226ff. But none of the elements is named in Plato's analysis of direction (62C3-63A6), since Plato's purpose is first to demonstrate that 'up' and 'down' have literally no place in a spherical universe, and then to show, by the introduction of the elements (63A6ff.), how it is that we have come to use the expressions 'up' and 'down', and 'heavy' and 'light', as we do. See further pp. 40ff.

²³ George S. Claghorn, *Aristotle's criticism of Plato's 'Timaeus'* (The Hague, 1954) 54-5.

²⁴ Richard D. Archer-Hind, *The 'Timaeus' of Plato, edited with introduction and notes* (London and New York, 1888) 230-1.

²⁵ Although Plato's text is unambiguous, Aristotle's statement and criticism of the theory (*De caelo* iv 1, 308a17-21; see pp. 187ff. below) is not explicit on this point, and the idea that the cosmic traveller makes his journey around the circumference of the world therefore also crops up in some medieval commentaries on the text of Aristotle.

'The supposed traveller will be using "above" and "below" with reference to every direction in succession, since at any moment he will think he is "on the top" of the body which is "beneath him"'.²⁶

But this too is inadequate as an explanation of Plato's text. On Cornford's interpretation, 'up' and 'down' will be used for different directions in turn, in so far as radial movement outwards from the surface of the earth, and inwards towards the centre of the earth, will differ for the cosmic traveller every time he changes his position on the surface of the globe. But this difference of direction will never lead to any 'inversion' of 'up' and 'down'. 'At *any* moment' (my italics), the cosmic traveller, on Cornford's interpretation, 'will think he is "on the top" of the body which is "beneath him"'. On this interpretation therefore there will never be any occasion when the central body itself will have been called both 'up' and 'down'.

And yet this is what Plato's text requires. Plato tells us that the cosmic traveller will call *the same part* of the central body 'up' and 'down', 63A3-4: ... ταὐτὸν αὐτοῦ κάτω καὶ ἄνω προσείποι. On Cornford's interpretation, the central body will be always, and only, 'down'.

Significantly, Cornford has attributed to the cosmic traveller what is in effect Aristotle's theory of 'up' and 'down'. For Aristotle, the circumference is always and only 'up' and the centre is always and only 'down', just as, for Cornford, the cosmic traveller is always 'on the top' of the body which is 'beneath' him.²⁷

This coincidence is as damning as is Cornford's failure to explain Plato's *ipsissima verba*. For although Aristotle claims that his own theory is a return to the way 'most people' think, nonetheless he specifically *contrasts* his own theory to the lesson that Plato meant to draw from the image of the cosmic traveller.²⁸

(iii)

The commentators I have quoted have overlooked one obvious, but essential distinction.

²⁶ *Cosmology* 263 n. 2.

²⁷ Aristotle's theory, *De caelo* iv 1, 308a21-9. Cf. pp. 188ff below.

²⁸ Aristotle, *De caelo* iv 1, 308a17-21; 'most people', 308a24. Even Cornford's point that 'the supposed traveller will be using "above" and "below" with reference to every direction in succession' (*Cosmology* 263 n. 2), finds its counterpart in Aristotle's argument that bodies which fall to, or rise from, the surface of the earth describe equal and not parallel angles (*De caelo* ii 14, 296b15-21; iv 4, 311b33-312a3). For Aristotle, as in practice for Cornford, the difference in direction which attaches to radial movements to or from the surface of the earth is subordinated to the belief that movement towards the surface of the earth, from the circumference, is movement 'downwards' and that movement away from the surface of the earth, towards the circumference, is movement 'upwards'. For the influence of Aristotle on Cornford's interpretation, see also pp. 396-9 below. For the companion error in Cornford's account of the measurement of fire, in the second part of Plato's analysis (63B2-C5), see p. 36 n. 7 below.

The cosmic traveller finds himself *πολλάκις ... ἀντίπους* (63A3): 'frequently standing upside down' to the way he was before. What is important, is not this image, but the conclusion which is drawn from it.

For the immediate sense of Plato's image, I take it is not in doubt. If we imagine two figures standing at the north pole and the south pole of a spherical earth, and if we now slide the two figures together, then we obviously find that each one is 'upside down' in relation to the other. And the same of course is true of figures standing at points diametrically opposed, anywhere on the surface of the earth.

What is important therefore, for an understanding of the *Timaeus*, is not this image itself, but the consequence which is drawn from it.

For the image itself could be used in more than one way. What is essential therefore, here as elsewhere, is that we should not simply foist onto the text of the *Timaeus* whatever consequence we (or Aristotle) might think most appropriate to the image, independently of the use that Plato has in fact made of it in the text of the *Timaeus*.

The question we need to ask therefore, and the question Cornford has failed to ask, or at least to answer, is quite simply: what is the consequence which Plato himself has drawn from the image he has chosen to use in this context?

More narrowly: what is the meaning of the words which Plato puts into the mouth of the cosmic traveller (... ταῦτόν αὐτοῦ κάτω καὶ ἄνω προσείποι, 63A3-4)?²⁹

(iv)

Simplifying slightly, I take Plato's point to be that:

1. For someone living north of the equator, the northern hemisphere, or the north pole, will appear as 'up' or 'above', while the southern hemisphere, or the south pole, will seem to be 'down' or 'below'.

²⁹ Cornford is not at the root of the error. Taylor provides a seemingly more sophisticated interpretation, which proves however to be no different from that of Cornford. Taylor tells us, *Commentary* 437-8, that movement 'from head to foot', if continued through the centre of the earth and out on the far side, would become movement 'from foot to head'. On this interpretation, movement in the same linear direction will have been successively 'down' (= from head to foot) and 'up' (= from foot to head); but even so, movement towards the surface of the earth is still invariably movement 'downwards', and movement away from the surface of the earth is still invariably movement 'upwards'. This is made explicit, in Taylor's summary of the interpretation earlier in his *Commentary*, p. 151: 'What we call "up" means simply the direction from the centre outwards, which, of course, varies at every point.' This summary is really no different from Cornford's construction, and therefore no different from the theory which Aristotle *contrasts* to the lesson to be drawn from the image of the cosmic traveller (*De caelo* iv 1, 308a17-21). For the background to Taylor's interpretation, see further pp. 396-9 below.

2. For someone living south of the equator, just the opposite (or so Plato supposes) will be the case: the northern hemisphere, or the north pole, will seem 'down' or 'below', and the southern hemisphere, or the south pole, will seem 'up' or 'above'.

Therefore someone who changes position from north to south will call the same part of the central body both 'up' and 'down', precisely as Plato tells us is the case with the cosmic traveller (*cf.* ταὐτὸν αὐτοῦ, 63A3).

To correct the simplification in my version, the difference between this account and the image of the *Timaeus* will be that Plato does not limit himself to any specific point on the earth's surface, the north and south poles in my example. As soon as he has walked half way round the earth's circumference, the cosmic traveller will repeatedly find himself 'the other way up' from the way he was at a corresponding point on the other side of the globe. Hence Plato writes that the cosmic traveller will be 'upside down' *πολλάκις* (63E3), while Aristotle, in repeating Plato's argument, writes even more scrupulously that the cosmic traveller will find himself 'upside down at every point' (*πανταχόθεν ἀντίπους*, *De caelo* iv 1, 308a20).

I conclude therefore, quite simply, that the cosmic traveller walks around the circumference of the earth, and that as he does so he calls different parts of the earth, or of the earth's surface, 'up' and 'down' in relation to the position at which he finds himself at each point on his journey, with the result that once he has walked half way round the earth he will be calling 'up' the part that previously was 'down', and *vice versa*.³⁰

(v)

The precise interpretation of the image of the cosmic traveller is essential to a clear understanding of the progression in Plato's argument.

In the course of his analysis of direction, Plato has dealt in turn with *circumference* and *centre* (62C8-D4), with *centre* and *circumference* (62D4-10), and now again with *circumference* and *centre* (62D10-63A4). This playing

³⁰ A partial parallel for the description of 'upper' and 'lower' poles may be found in Aristotle's discussion of 'right' and 'left' in the universe (*De caelo* ii 2, 284b6ff.), where different criteria lead to the description of opposite poles as variously 'up' and 'down'. This passage will be discussed in a separate Note, in conjunction with Aristotle's criticisms of Plato's theory of direction: see pp. 185-91 below, and pp. 387ff., esp. pp. 395-403 below. In this later discussion I also take account of the relation between the 'cosmic traveller' in the *Timaeus* and the terminology which Plato uses in the myth of the *Phaedo* (pp. 391ff. below).

It should be noted that Aristotle's account of 'up' and 'down' in book two of the *De caelo* is quite different from the analysis he gives of an absolute 'up' and 'down' in the fourth book, and which he *contrasts* to Plato's theory (iv 1, 308a17-29; see pp. 185-91 below).

with the sequence of words and ideas will seem childish only to those who are out of sympathy with much of the style and thought of the *Timaeus*.

At the same time, the various stages in Plato's argument do not simply repeat themselves. Thus initially Plato claims that the centre, or 'the central place', cannot be described as by nature 'up' or 'down' (62D6-8). The image of the cosmic traveller is not a simple repetition of this denial: for now Plato claims that no one *part* of the central body can be distinguished from any other as 'up' or 'down'.

Altogether therefore Plato has claimed that 'up' and 'down' can attach neither to the centre as such, as distinct from the circumference (cf. 62D6-8), nor to any one part of the centre as distinct from any other (the image of the cosmic traveller, 63A2-4).

(vi)

This progression in Plato's argument is intended, I would suggest, to complement the argument derived from Anaximander, and repeated in the *Phaedo*, on the 'likeness' of the extremes (62D10-63A2).

In his initial account of the central body (62D10ff.), Plato's preoccupation had been to prove that there was no point on the circumference which would be nearer to the centre, and which might be able therefore to draw the earth towards it.

The image of the cosmic traveller (63A2ff.) I suspect is intended to flow in part from the supposed objection that while the circumference might provide no direction for the central body to move towards, the earth, or the central body itself, might perhaps start off in some direction determined by the distribution of its own parts.

From this point of view therefore, the sequence of thought in Plato's argument will be that:

1. No point on the circumference could act as a terminal point for the movement of the earth, any more than any other (62D10-63A2).
2. Equally, no part of the central body itself can be so qualified as to determine the movement of the whole (63A2-4).³¹

³¹ I claim this as *in part* Plato's intention: the image of the cosmic traveller I believe has a different, and complementary, function in relation to the 'common error' (62C5-8), whereby "'up" and "down" divide the whole between them'. See further pp. 393ff. below.

One slight, but possibly significant anomaly. Plato denies that the centre as a whole is 'up' or 'down' (62D6-8) and later that any part of the centre can be exclusively 'up' or 'down' (63A2-4). He denies, by implication, that any part of the circumference is 'up' or 'down' (62D8-10). But he does not deny that the circumference as a whole is 'up' or 'down'. This possibility is in fact obviously excluded by Plato's general conclusion that no place in the universe is 'up' or 'down' (63A4-6). But this denial is less immediately relevant to Anaximander's argument, for even if *per impossibile* the whole circumference were

(vii)

This progression in Plato's argument, and the undercurrent of allusion to Anaximander, is obscured by Cornford's mistranslation of Plato's description of the circumference, in the sentence I analysed earlier (62D8-10), and by his misinterpretation of the image of the cosmic traveller (62A2-4).

For the two errors are complementary. Cornford's mistranslation of the sentence at 62D8-10 obscures the point that 'no one part of the circumference is different from any other in being closer to the centre than any of the parts on the opposite side'. His misinterpretation of the image of the cosmic traveller obscures the *equivalent* point that 'up' and 'down' cannot apply exclusively to any one part of the central body as distinct from any other.

These two points jointly, I would suggest, contain Plato's repetition, or adaptation, of the argument from Anaximander: no point on the circumference could act as a terminal point for the movement of the earth any more than any other (62D10-63A2); and no part of the central body itself can be so qualified as to determine the movement of the whole (63A2-4).³²

§ 6. PLATO'S UNIVERSE

Plato concludes his analysis of direction by re-stating that no part of the whole can rightly be described as 'up' or as 'down', 63A4-6: τὸ μὲν γὰρ ὅλον, καθάπερ εἴρηται νυνδὴ, σφαιροειδὲς ὄν, τόπον τινὰ κάτω, τὸν δὲ ἄνω λέγειν ἔχειν οὐκ ἔμφορος.

(i)

At first sight, this conclusion is a trifle disconcerting.

'up' or the whole circumference were 'down', there would still be no reason for the earth to move away from the centre towards one part of the circumference more than towards any other. The point relevant to Anaximander's argument is that no *part* of the circumference should be different from any other, and this is precisely the point which Plato stresses in the sentence I have analysed (62D8-10).

³² I write of Plato's 'repetition or adaptation' of the argument from Anaximander. Both features in the argument which I attribute to Plato, that the earth is immobile because of the 'indifference' (1) of the circumference and (2) of the central body itself, recur in Simplicius' account of Anaximander's argument, *De caelo* 532. 16-19, cf. 532. 10-11 and 24-5. But there is not the same division of ideas in Aristotle's account of Anaximander (references p. 16 n. 20 above), and one may doubt whether the *second* argument would be possible unless the earth itself were spherical. The 'central body' of the *Timaeus* obviously is spherical (although this has been denied, see p. 390 below); Anaximander's earth was not spherical (for the size and shape of Anaximander's earth, see my article 'Anaximander's measurements', *CQ* n.s. 17 [1967] 423-32, esp. 424-5).

1. The cosmic traveller describes the same part of the earth, or of the earth's surface, as both 'up' and 'down' (63A3-4: ταῦτόν αὐτοῦ κάτω καὶ ἄνω προσείποι).

2. How does this justify the conclusion that no part of the whole can rightly be described as 'up' or 'down' (63A4-6), and in particular the claim that 'the centre' or 'the central place' is by nature *neither* 'up' *nor* 'down' (62D6-8: ... οὔτε κάτω πεφυκώς οὔτε ἄνω λέγεσθαι δίκαιος)?

The answer may be found in a comparison with Plato's *Phaedo* where, in the opening stages of the final argument for the immortality of the soul (102A10-107A1), Plato considers the question of comparative size.

In the *Phaedo*, Plato's point is that Simmias is larger than Socrates and smaller than Phaedo. Simmias 'has the name of being small as well as large, because he is in the middle of both of them' 102C10-11: ἐπωνυμίαν ἔχει σμικρὸς τε καὶ μέγας εἶναι, ἐν μέσῳ ὧν ἀμφοτέρων. From this it follows that Simmias is not 'born by nature' to be larger than Socrates. He is so only in virtue of the largeness which he 'happens' to have, 102C1-2: οὐ γάρ που πεφυκέναι Σιμμίαν ὑπερέχειν (sc. Σωκράτους ὁμολογεῖς) τούτῳ, τῷ Σιμμίαν εἶναι, ἀλλὰ τῷ μεγέθει ὃ τυγχάνει ἔχων.

There is here the same assumption as in the present passage of the *Timaeus*, that if something can be given opposite designations, even if from different points of view, then it cannot be reckoned to possess either designation 'by nature', or as we might say 'in its own right'. Thus it is that someone who walks around the central body will call the same part of it 'above' and 'below' (63A3-4); but despite, or rather because of, this, the centre cannot 'rightly' be spoken of as possessing either of the two designations, 'above' or 'below', 'by nature' (62D6-8).

(ii)

It is worth noting that in the *Phaedo* as in the *Timaeus* the idea that something is 'born by nature to be as it is' is not used only negatively.

Thus Simmias is not 'born by nature' to be larger than Socrates. But later we are told that threeness—whether the form of three, or the number three, is not immediately clear from the course of Plato's argument at this point—is 'born' or 'constituted by nature' to be odd. Hence the number three cannot 'stay behind' and become even. At the approach of evenness, it must either withdraw, 'get out of the way of evenness', and so continue to be three, or else it will perish (*Phaedo* 102C1-9, 103E9-104C4).

So too in the *Timaeus*, the criterion of identity 'by nature' is used positively as well as negatively. There are not 'by nature' two opposite

places, 'up' and 'down', which divide the whole between them (62C5-8). The centre cannot rightly be spoken of as 'up' or 'down' 'by nature' (62D6-8). But the world and the circumference possess 'by nature' shape and position respectively.

1. 'The whole universe is spherical', 62C8-D1: τοῦ γὰρ παντὸς οὐρανοῦ σφαιροειδοῦς ὄντος. It is 'born by nature to be as it is', 62D4-5: τοῦ δὲ κόσμου ταύτῃ πεφυκότος. It is 'by nature evenly distributed in every direction, 62D10: τοῦ δὲ (sc. κόσμου) ὁμοίως πάντῃ πεφυκότος.

2. The points which are equidistant from the centre and are therefore 'extremities' are all 'equally and in the same sense born by nature to be extreme', 62D1-2: ὅσα μὲν ἀφεστῶτα ἴσον τοῦ μέσου γέγονεν ἔσχατα, ὁμοίως αὐτὰ χρῇ ἔσχατα πεφυκέναι.³³

(iii)

The *Timaeus*, it is true, does not therefore launch out into the postulation of forms, as does the analysis in the *Phaedo*. But again it is worth noting that there has been something at least superficially similar.

1. In the *Phaedo*, Plato's conclusion is that only 'largeness itself' can be reckoned as always and only large: αὐτὸ τὸ μέγεθος (102A10-103C9).

2. In the *Timaeus*, Plato concludes that the centre cannot be constituted 'by nature' as up or down, for it is precisely 'what is itself in the centre': αὐτὸ ἐν μέσῳ (62D8).

Admittedly, in the *Timaeus* the expression is adverbial and not adjectival. It cannot designate a form. But what perhaps remains in Plato's conception is the notion of simplicity, or of exclusiveness, as a criterion of identity.

1. In the *Phaedo*, largeness itself is simply large: it cannot be to any degree, or in any respect, small.

2. Similarly, in the *Timaeus*, the centre is simply so: it cannot truly be designated as being either up or down.

The echoes of Aristotle's notion of 'absolute' weight are here already audible; I shall explore them in my third and fourth volumes.³⁴

³³ The two expressions πεφυκότος, 62D5, and πεφυκώς, D7, are included (without illuminating comment) in the passages quoted by Dietrich Mannsperger, *Physis bei Platon* (Berlin, 1969) 132.

³⁴ Meanwhile cf. pp. 315-16 and pp. 427-9 below.

(iv)

For the moment, I conclude only that the analysis of direction in the *Timaeus* is not merely adversative. The falsity, or at least the unreliability, of popular terminology has been established within a positive scheme of Plato's own convictions on the nature of the universe.

- The world is 'by nature' spherical.
- The extremities are 'equally and in the same sense constituted by nature as extreme'.
- The centre cannot properly be designated as 'by nature' up or down; it is simply 'itself in the centre'.

From this it follows that if the central point or the central place is occupied by a body, then this body will remain 'equally balanced' in the centre, because no part of the circumference and no part of the central body itself could be so characterised as to determine its movement in any one direction rather than in any other.

Two features need to be singled out in this description of the universe.

First, no mention has been made of the elements; even the hypothetical central body, which Plato clearly intends to represent the earth, is described, purely geometrically so to speak, as $\tau\iota \dots \sigma\tau\epsilon\rho\epsilon\acute{o}\nu$ (62A12).

Secondly, although Plato has been careful to rid this 'geometrical' description of the cosmos of opposite 'names' (cf. 62D11), which in the context will of course be primarily the opposite 'names' of 'up' and 'down', nonetheless he has not rid the universe of all notion of opposition.

- The centre is 'opposite' to all points on the circumference without distinction ($\kappa\alpha\tau\alpha\nu\tau\iota\chi\rho\acute{\upsilon}$, 62D4).
- No one part of the circumference is any closer to the centre than any of the parts which are 'opposite' to it ($\kappa\alpha\tau\alpha\nu\tau\iota\chi\rho\acute{\upsilon}$, 62D10).

These two features will be of crucial importance when Plato turns from the analysis of direction only to the analysis of direction and weight.³⁵

³⁵ I have taken for granted in this section the results of my analysis in 'The last argument of Plato's *Phaedo*', Part I *CQ* n.s. 17 (1967) 198-231, Part II *CQ* n.s. 18 (1968) 95-106. For the interpretation of the metaphor, 'staying behind' and 'getting out of the way of', see also *CQ* n.s. 27 (1977) 297-9. Some useful additional points for the interpretation of this part of the *Phaedo* can be gleaned from C. L. Stough, 'Forms and explanation in the *Phaedo*', *Phronesis* 21 (1976) 1-30. Otherwise subsequent literature makes very disappointing reading, for example David Gallop, *Plato 'Phaedo', translated with notes*, in the *Clarendon Plato series* (Oxford, 1975). Gallop's notes on the last argument (pp. 192ff.), read more like piecemeal jottings than a sustained commentary, while his occasional criticisms of the analysis I had given seem to me, with the best will in the world, merely captious.

To take only one example at random: to explain a reservation in Plato's text (103E2), I distinguished attributes which have no essential predication (e.g. 'large' and 'small' in Plato's analysis) and attributes (e.g. 'hot' and 'cold') which may be predicated either

essentially (of fire and snow respectively) or non-essentially. As an instance of non-essential predication, I gave water which can be either hot or cold (p. 211 n. 2). What possible relevance can there be in Gallop's objection (p. 199) that water is, nonetheless, essentially wet: 'water is, *arguably*, always wet and never dry' (my italics)? Gallop has confused the point I wished to illustrate, attributes which can be predicated essentially or non-essentially, with the quite different question, of which there is no mention in Plato's text and certainly none in my commentary: whether an object can exist which has no essential predication. How can one hope to forestall such scatter-brained irrelevancies?

CHAPTER TWO

THE ANALYSIS OF WEIGHT

§ 1. THE TWO OBSERVERS

Plato marks the commencement of the second stage of his analysis by re-stating his opening allusion to the common error that up and down ‘divide the whole between them’ (62C5-8). The account of heavy and light, Plato tells us, will explain how it is that we have ‘grown accustomed’ to using these words as we do, 63A6-B1: ὅθεν δὲ ὠνομάσθη ταῦτα καὶ ἐν οἷς ὄντα εἰθίσμεθα δι’ ἐκεῖνα καὶ τὸν οὐρανὸν ὅλον οὕτω διαιρούμενοι λέγειν, ταῦτα διομολογητέον ὑποθεμένοις τάδε ἡμῖν.

The solution lies in the comparison between two observers. The behaviour, and the terminology, of an observer on earth must be interpreted with reference to the behaviour and the terminology of an imaginary observer stationed at the circumference of the universe.

(i)

The assumption of Plato’s theory is that the earth lies at the centre of the universe, and that fire is accumulated at the circumference, with air—if one dare allow oneself the expression—below it.

Plato’s previous point required us to imagine someone walking around the surface of the spherical earth. His present point requires us to visualise someone in a complementary position, standing on the inner surface of the circumference, and looking inwards, as it were.

This figure we are to imagine as holding a pair of scales, into either side of which he places a larger and a smaller portion of fire. He then lifts the scales away from the main body of fire, into the region of air.

In this circumstance, Plato tells us, the larger quantity of fire will weigh more, for it will be more difficult to drag the larger quantity away from the main body of the element to which it belongs.

From this Plato concludes that the larger quantity should be designated as moving *downwards*, and as being *heavy*, while the smaller quantity should be designated as moving *upwards*, and as being *light*.

Plato writes, 63B2-C5: εἴ τις ἐν τῷ τοῦ παντὸς τόπῳ καθ’ ὃν ἡ τοῦ πυρὸς εἵληχε μάλιστα φύσις, οὗ καὶ πλεῖστον ἂν ἡθροισμένον εἴη πρὸς ὃ φέρεται, ἐπεμβὰς ἐπ’ ἐκεῖνο καὶ δύναμιν εἰς τοῦτο ἔχων, μέρη τοῦ πυρὸς ἀφαιρῶν ἱσταίη τιθεὶς εἰς πλάστιγγας, αἴρων τὸν ζυγὸν καὶ τὸ πῦρ ἔλκων εἰς ἀνόμοιον ἀέρα βιαζόμενος δῆλον ὡς τοῦλαττόν που τοῦ μείζονος ῥᾶον βιάται· ῥώμῃ γὰρ μία

δυσὶν ἅμα μετεωρίζομένοις τὸ μὲν ἔλαττον μάλλον, τὸ δὲ πλεόν ἦττον ἀνάγκη που κατατεινόμενον συνέπεσθαι τῇ βίᾳ, καὶ τὸ μὲν πολὺ βαρὺ καὶ κάτω φερόμενον κληθῆναι, τὸ δὲ σμικρὸν ἐλαφρὸν καὶ ἄνω.

(ii)

The same rule Plato then applies to the behaviour of earth, as measured from the position in which we actually find ourselves.

Standing on the earth's surface, and weighing different quantities of earth, we shall find it more difficult to lift the larger quantity, because we are dragging it away from its like, and easier to lift the smaller piece.

Hence Plato again concludes that the larger portion is reckoned as *heavy* and as travelling *downwards*, while the smaller portion is reckoned as *light* and as travelling *upwards*, although for the sake of variety Plato reverses the order in which the two pairs of terms are listed.

Plato writes, 63C5-D4: ταῦτόν δὲ τοῦτο δεῖ φωρᾶσαι δρῶντας ἡμᾶς περὶ τόνδε τὸν τόπον. ἐπὶ γὰρ γῆς βεβῶτες γεώδη γένη διίστάμενοι, καὶ γῆν ἐνίστε αὐτήν, ἔλκομεν εἰς ἀνόμοιον ἀέρα βίᾳ καὶ παρὰ φύσιν, ἀμφοτέρα τοῦ συγγενοῦς ἀντεχόμενα, τὸ δὲ σμικρότερον ῥᾶον τοῦ μείζονος βιαζομένοις εἰς τὸ ἀνόμοιον πρότερον συνέπεται· κοῦφον οὖν αὐτὸ προσειρήκαμεν, καὶ τὸν τόπον εἰς ὃν βιαζόμεθα, ἄνω, τὸ δ' ἐναντίον τούτοις πάθος βαρὺ καὶ κάτω.

(iii)

By the introduction of an imaginary observer, at the circumference of the universe, Plato intends us to realise how it is that we have come to use 'up' and 'down' in the conventional, but defective, sense which he had outlined for us in his preliminary criticism, and which he had promised to explain for us by the account of heavy and light.

We have first to reflect upon our position at the centre of a spherical universe, where no part of the centre or of the circumference can in itself be designated as 'by nature' up or down.

We have then to 'catch ourselves out' (φωρᾶσαι) performing on earth the same operation that the imaginary observer is visualised as performing at the circumference: in either case, we are using 'up' and 'down' consistently, but relatively to our own position.

Plato's point is that we have in fact no more right to arrogate the use of those terms exclusively to movement towards or away from the earth than the imaginary observer in the region of fire would have to use the same terms exclusively for movement towards or away from the circumference.

The truth, therefore, Plato will tell us in the sentences which follow (63D4-E3), is that each term in the pair up and down, and each term in

the pair heavy and light, will have an *opposite* reference, depending on whether it is used in relation to the centre, or in relation to the circumference.

It is only because we pass our days on the surface of the earth that we have 'grown accustomed' to using each term as if it had a *single and exclusive* reference.

(iv)

This analysis is more complex than may at first sight appear. If for the moment I single out only Plato's remarks on direction, leaving aside the account of weight, then Plato's point is that:

1. Standing on the earth, we reckon movement away from the centre as movement upwards, and movement towards the centre as movement downwards.

2. But if we were to stand on the circumference, looking inwards as it were, then Plato tells us that we would reckon movement away from the circumference as movement upwards, and movement towards the circumference as movement downwards.

In this later analysis, therefore, the original opposition of the cosmic traveller (63A2-4), between up and down as applying in turn to different parts of the earth, or to different points on the earth's surface, has been transposed to form a single term in a new opposition.

1. In Plato's earlier opposition (63A2-4), the same point—any point—of the earth's surface was reckoned as up and down, in turn.

2. In this later analysis (from 63A6), movement towards any part of the earth's surface is movement downwards, while only movement away from the earth's surface is reckoned as movement upwards.

Thus in Plato's earlier analysis, the observer moved, and various parts of the earth, or points on the earth's surface, were named by him as up and down, in turn. By contrast, in this subsequent analysis, the significance of the observer on earth is determined by his opposition to the observer stationed at the circumference, and it is the movement of different portions of earth which determines the use of up and down, at the same time.

These two changes transform the whole notion of 'up' and 'down', away from the idea that no part of a spherical universe can be 'by nature' up or down, to the idea, at this point in the argument not acknowledged theoretically or in principle, but acknowledged as it were in practice, that up and down have a real, if limited, significance.

1. In the image of the man walking round the central body, the point was that the human observer would use up and down *inconsistently*, in the sense that one and the same place appeared to him, at different times, both as 'up' and as 'down', and could not, therefore, properly be either.

2. In this later passage, the observer at the centre and the observer at the circumference each uses up and down *consistently* from his own viewpoint, and such inconsistency as there is lies between the two accounts, each taken as a whole.

For the point is that instead of walking round the central body, and therefore describing the same part of the body as up and down in turn, the observer in the later analysis is contrasted to an imaginary observer at the circumference, and therefore uses up and down in a new and consistent sense, to mean movement from, and towards, the centre.¹

(v)

This extension of a simple opposition to form one term in a more complex opposition seems to me characteristic of Plato's thinking. The *Phaedo* again provides a parallel: the extension of an opposition in this way is an essential feature of the last argument of the dialogue.

When life and death are introduced into the earlier arguments of the *Phaedo*, they form a simple opposition, determined by the soul's being attached to, or separate from, the body. In the final argument, Plato in effect engrosses life and death in this simple form into a single term in a new opposition, between, ultimately, existence and non-existence. Life and death in the old sense, of the soul's attachment to or separation from

¹ It is, I think, a confused recognition of this development which leads Giuseppe Zannoni, in an edition and translation of the *De caelo* (Pavia, 1936) 47, to write of 'il secondo, più valido, argomento di Platone, taciuto qui forse di proposito da Aristotele' (my italics: the reference is to *De caelo* iv 1, 308a17-21, quoted below p. 187). I do not quite see how the second analysis (63A6ff.) provides a 'more valid' argument than the first (62C3-63A6). The point is rather that in his analysis of direction Plato draws a negative conclusion, that no part of the universe is 'by nature' up or down (62C3-63A6), while the later argument (63A6ff.) yields a positive, if qualified, meaning for the oppositions of direction and of weight.

There is nothing particularly sinister in Aristotle's citing, at this point, only the earlier analysis. Aristotle is opposed to the whole notion of 'up' and 'down' having only a relative sense, and he would therefore be no less opposed to the positive conclusion, that 'up' and 'down' can be used indiscriminately of centre and circumference, than he is to the negative conclusion, that the centre and the circumference can be neither 'up' nor 'down'. It is however rather more natural for Aristotle to attach his criticism of Plato to the earlier and negative argument, since it is here that Plato sets out explicitly to oppose the belief which, *à une nuance près*, Aristotle shares with the 'common error', namely that the circumference is 'up' and that the centre is 'down'. On this point, see further ch. IX § 3, pp. 188ff. below.

the body, are now taken together as equally existence or 'life' in a new sense, and are jointly opposed to non-existence, or to death conceived not as the separation of soul from body but as the passage to sheer non-existence.²

The movement of thought in the *Timaeus* is similar.

1. In Plato's initial account of the cosmic traveller (63A2-4), 'up' and 'down' are applied to different parts of the earth, or to different points on the earth's surface, in turn.

2. But in Plato's later analysis of an earth-bound observer (63C5-D4), 'up' and 'down' in this sense are *both* taken to represent movement 'downwards', and only movement away from the earth's surface is reckoned as movement 'upwards'.

From this point of view, 'upwards' acquires a new significance, comparable to the 'new' notion of death as the passage to non-existence in the *Phaedo*. For in the description of the cosmic traveller different parts of the earth's surface had been described as 'up' and 'down' in turn, and no account was there taken of movement away from the surface of the earth.

(vi)

On the other hand, the innovation, in the *Phaedo* as in the *Timaeus*, is concealed by the fact that the 'new' definition in a sense answers only to the everyday conception with which the argument had begun.

1. In the *Phaedo*, Cebes' fear, even if it had not been explicitly formulated, was from the start a fear, not of transmigration, but of extinction. This, Socrates tells us, in resuming Cebes' objection (95B-E), is the fear that anyone must feel who faces death.

2. So too in the *Timaeus*: the notion of 'up' as meaning 'away from the surface of the earth' (63C5-D4) is, at first blush, no more than a repetition of the earlier and naïve assumption that 'upwards' is the direction to which bodies move 'against their will' (*cf.* 62C7-8).

But the interlocutor of the *Phaedo*, as also the reader of the *Timaeus*, has to pay a price for this return to an earlier implicit or naïve view.

1. The 'new' definition of death in the *Phaedo* (*cf.* 91D2-7) is introduced only when Cebes has agreed to belief in the existence of forms and in the possible existence of the soul apart from the body.

² This is the interpretation of the *Phaedo* (102A10ff.) that I hope to have established in 'The last argument of Plato's *Phaedo*', Part II, *CQ* n.s. 18 (1968) 95-106.

2. In the *Timaeus*, the use of 'upwards' as meaning 'away from the surface of the earth' is reinstated only within the context of an additional and quite different use of 'up' and 'down' to mean respectively away from and towards the circumference (cf. 63B2-C5).

In either case, therefore, the context of the 'reversal' is all important. In the *Phaedo*, the 'new' definition of death is made explicit only when Simmias and Cebes have abandoned their belief in a simple materialism (the 'childish fear' of 77D-E). Similarly, in the *Timaeus*, we return to a definition of 'upwards' as meaning 'away from the surface of the earth', only within a context which effectively belies the earlier and naïve assumption which Plato condemned at the beginning of his analysis, namely that there are 'by nature two opposite places, "up" and "down", which divide the whole between them' (cf. 62C5-8).

For the earth-bound observer is allowed to return to his settled way of thinking (cf. εἰθίσμεθα, 63A7), where 'upwards' means 'away from the earth's surface'; but he is allowed to do so, only because he has abandoned the naïve and popular assumption that 'up' and 'down' in this sense 'divide the whole between them'.³

(vii)

From this point of view, the potential discrepancy that I noted in the final section of my first chapter gains a new perspective.⁴ Plato first

³ This progression in Plato's argument is obliterated in Cornford's interpretation, where the use of 'up' and 'down' in the measurement of fire at the circumference (63B2-C5) is in practice not distinguished from the use of 'up' and 'down' in the measurement of earth (63C5-D4), and is further identified with the use of 'up' and 'down' in the image of the cosmic traveller (63A2-4), with the added complication that Cornford's account of the cosmic traveller is in any case erroneous. Thus Cornford tells us that 'at any moment' the supposed traveller 'will think he is "on the top" of the body which is "beneath him"' (*Cosmology* 263 n. 2; cf. pp. 18-19 above). This assumes that the earth is invariably 'below'. The same assumption underlies Cornford's account of the measurement of fire, earlier in his commentary: 'If we can imagine someone stationed aloft in the region of fire and trying to force fire "downwards" into the alien region of air, he would find that fire resisted his efforts and he would have to call it "heavy"' (*Cosmology* 124). Here movement from the region of fire to the region of air, centripetal movement therefore, is movement 'downwards', even for the measurement of fire, although Plato clearly intends (63B2-C5) that in the measurement of fire movement 'inwards' from the circumference should be accounted as movement 'upwards'. It is just this peculiarity in the measurement of fire at the circumference which allows us to return to our old settled ways of thinking—because we do so only for the measurement of earth at the centre.

Cornford's two errors (*Cosmology* 124 and 263 n. 2) reinforce one another. In Cornford's account of the measurement of fire, 'downwards' describes centripetal movement, precisely as is implied in Cornford's account of the cosmic traveller—and precisely as is the case in Aristotle's theory (*De caelo* iv 1, 308a14ff.). For the origins of Cornford's error, see further pp. 396-9 below, and for the impossibility of adapting Cornford's interpretation to the next step in Plato's argument (the 'alignment of opposites', 63D4-E3), see p. 36 n. 7 below.

⁴ Pp. 23-5 above.

argues that 'the centre' or 'the central place' is *neither up nor down* (62D6-8). But in his description of the cosmic traveller the same part of the earth's surface is *both up and down*, in turn (63A3-4).

Comparison with the *Phaedo* shows that for Plato's immediate purpose this is a distinction without a difference. For the principles outlined in the *Phaedo* ensure precisely that if something can be given opposite designations, even if from different points of view (Simmias is *taller* than Socrates, and *shorter* than Phaedo), then neither designation can belong to it, as Plato would say, 'by nature'.

But from another point of view the difference between '*neither up nor down*' and '*both up and down*' is an essential element in the progress of Plato's argument.

The assertion that the centre can be *neither up nor down* undoes the conventional assumption that up and down are 'opposite places' which 'divide the whole between them'. In its immediate context, the image of the cosmic traveller is used merely to reinforce this conclusion (*cf.* 63A4-6). But the same image also prepares the reader for a further positive use of 'up' and 'down' to mean away from, or towards, the surface of the earth (63C5-D4). This new positive terminology is made possible, because we have abandoned the original assumption that 'up' and 'down' divide the whole between them, and because we have agreed to enlarge our view to include the terminology we should have to use if we stood at the circumference, and not at the centre, of the world.

From this point of view, the image of the earth-bound observer has two different but complementary functions. The image first serves to *undermine* the naïve assumption that up and down divide the whole between them. But it helps also to *reinstate* the everyday use of up and down, as meaning away from and towards the surface of the earth, once we have abandoned the naïve assumption in which that terminology had originally been embedded.

All this may seem impossibly pedantic and pedantic; but a close understanding of Plato's procedure at this point will prove essential for calculating the precise scope of Plato's theory, when we come to consider what plausibility, if any, there may be in the interpretations which modern scholars have grafted onto the text of the *Timaeus*.⁵

⁵ For the use made of this point in my analysis, see esp. pp. 62ff. below. The progression in Plato's argument will be clearer in the light of my later discussion, where I argue that the 'common error' of the *Timaeus* is the same as the belief of 'the majority' in a passage from Aristotle's *De caelo* (iv 1, 308a22-9). The assumption of the 'common error' (62C3-8) is then that the earth lies beneath a hemispherical sky: earth is 'below' and the sky 'above'. The image of the cosmic traveller (63A2-4) has a *negative* function in so far as it shows the impossibility of transposing this terminology to a spherical universe with a central free-swinging earth (*cf.* 63A4-6), and a *positive* purpose in so far as the terminology

§ 2. THE ALIGNMENT OF OPPOSITES

So far, Plato has described the two observers separately. In the sentences which follow, Plato joins the two circumstances: the measurement of fire at the circumference, and of earth at the centre.

Since the main body of fire and the main body of earth occupy different positions, the one being accumulated at the circumference, and the other at the centre, it must follow, Plato tells us, that what is light or heavy, up or down, in one position is the opposite of what is light or heavy, up or down, in the opposite position.

Plato writes, 63D4-E3: ταῦτ' οὖν δὴ (*sc.* heavy and light, up and down) διαφόρως ἔχειν αὐτὰ πρὸς αὐτὰ ἀνάγκη διὰ τὸ τὰ πλήθη τῶν γενῶν τόπον ἐναντίον ἄλλα ἄλλοις κατέχειν· τὸ γὰρ ἐν ἐτέρῳ κοῦφον ὃν τόπῳ τῷ κατὰ τὸν ἐναντίον τόπον ἐλαφρῷ καὶ τῷ βαρεῖ τὸ βαρὺ τῷ τε κάτω τὸ κάτω καὶ τὸ ἄνω τῷ ἄνω παντ' ἐναντία καὶ πλάγια καὶ πάντως διάφορα πρὸς ἄλληλα ἀνευρεθήσεται γιγνόμενα καὶ ὄντα.

(i)

I shall note later a potential ambiguity in the two expressions 'what is heavy' and 'what is light'. For the moment, I pursue only the sense which follows directly from the course of Plato's analysis up to this point, and the sense which I believe will finally be confirmed by reflection upon Plato's analysis as a whole.⁶

If we follow Plato's two earlier examples exactly, then the formulation for the two oppositions of heavy and light will be as follows.

Heavy

What is heavy in one place, say a larger quantity of fire at the circumference, will be the opposite of what is heavy in the opposite place, i.e. a large quantity of earth measured from the centre.

Light

What is light in one place, say a smaller quantity of fire measured at the circumference, will be the opposite of what is light in the opposite place, i.e. a small quantity of earth measured from the centre.

(ii)

The oppositions of up and down are not quite so straightforward. If we were to follow only the example of the person walking around the surface of the earth, then we should have the following formulation.

of the cosmic traveller is a first approximation to the 'relativistic' use of 'up' and 'down' which Plato will establish in his analysis of weight and direction (63A6ff.). For this discussion see pp. 399ff. below.

⁶ For the ambiguity, see pp. 55ff. below.

Up

What is 'up' viewed from one position, say the northern hemisphere for someone living north of the equator (as explained earlier, this version simplifies slightly), is the opposite of what is 'up' from the opposite position, i.e. the southern hemisphere for someone living south of the equator.

Down

What is 'down' from one position, say the southern hemisphere for someone living north of the equator, is the opposite of what is 'down' from the opposite position, i.e. the northern hemisphere for someone living south of the equator.

But this is clearly not Plato's intention. For if we follow only this earlier example, then the opposite places will be opposite parts of the central body, or opposite points on the earth's surface. It is more natural, indeed essential, for the opposite places in the present passage to be the same in all four examples, in the two examples of up and down as well as in the two examples of heavy and light. In that case, the opposite places must be centre and circumference, and the formulations for up and down will then be as follows.

Up

What is 'up' in one position, say away from the centre if we are standing at the centre, will be the opposite of what is 'up' from the opposite position, i.e. away from the circumference if we are standing at the circumference.

Down

What is 'down' from one position, say towards the centre if we are standing at the centre, will be the opposite of what is 'down' from the opposite position, i.e. towards the circumference if we are standing at the circumference.⁷

⁷ Does it seem all too obvious to spell out, as I have done, that 'up' and 'down' in Plato's present analysis (the 'alignment of opposites', 63D4-E3) look back to the use of 'up' and 'down' in the measurement of fire (63B2-C5) and of earth (63C5-D4; cf. pp. 28-9 above), and *not* to the (quite different) use of 'up' and 'down' in the image of the cosmic traveller (63A2-4; pp. 17-18 above)?

The view I have troubled to disclaim is by implication the view which Cornford has adopted, in so far as Cornford seeks to apply to the measurement of fire the same erroneous analysis which he has applied to the image of the cosmic traveller. In both cases, Cornford takes the centre to be 'down' or 'below', and movement from the circumference towards the centre, centripetal movement therefore, to be movement 'downwards' (*Cosmology* 124, 263 n. 2; cf. pp. 18-19 and p. 33 n. 3 above). With this interpretation, it will be impossible to explain how 'what is "down" in one place is the opposite of what is "down" in the opposite place' (cf. 63D4-E3), since, on Cornford's interpretation, centripetal movement will be movement 'downwards' both for the measurement of fire at the circumference and presumably also for the measurement of earth at the centre. In fact, for the measurement of fire, Plato clearly intends that movement *inwards* from the circumference, centripetal movement therefore, should be accounted as movement *upwards* (cf. 63B2-C5). For the origins of Cornford's view, see pp. 396-9 below.

(iii)

In this way, the examples of heavy and light and of up and down are precisely parallel. In both sets of examples, the 'opposite places' are centre and circumference.

From the centre

- 'Heavy' corresponds to a large quantity of earth.
- 'Light' corresponds to a small quantity of earth.
- 'Up' means away from the centre.
- 'Down' means towards the centre.

From the circumference

- 'Heavy' corresponds to a large quantity of fire.
- 'Light' corresponds to a small quantity of fire.
- 'Up' means away from the circumference.
- 'Down' means towards the circumference.

The oppositions of 'heavy' and 'light', and of 'up' and 'down', are therefore as follows, viewed in turn from the centre and from the circumference.

Heavy

- A large quantity of earth.
- A large quantity of fire.

Light

- A small quantity of earth.
- A small quantity of fire.

Up

- Away from the centre.
- Away from the circumference.

Down

- Towards the centre.
- Towards the circumference.

(iv)

It is important to appreciate precisely what has happened here.

At the start of Plato's analysis, in the description of what I called the 'common error' (62C3-8), we were introduced in effect to three sets of oppositions:

1. An opposition of place (τόπους ... ἐναντίους, 62C5-6), which in the course of his analysis Plato treats as an opposition of centre and circumference (cf. καταντικρύ, 62D4).

2. Two oppositions, of weight and of direction, i.e. two pairs of opposite 'names' (cf. *ὀνόματα ... ἐναντία*, 62D11), 'heavy' and 'light' and 'up' and 'down'.

Plato's quarrel with the common error turns on the relation between the opposition of place and the oppositions of weight and of direction.

The assumption of the common error is that there is a simple one-to-one correspondance between each term in the three oppositions.

1. One opposite place is 'up'; the other opposite place is 'down'.
2. By implication, bodies which move 'down' are 'heavy'; bodies which move (or are moved) 'up' are 'light'.

Plato will abandon this simple one-to-one relationship.

Plato's initial conclusion, in his analysis of direction (62C8-63A6), is merely negative: the opposite 'names' of 'up' and 'down' cannot 'rightly' be applied to centre or to circumference in a spherical universe.

But in the analysis of weight and direction (63A6ff.), we have a new and positive conclusion. 'Up' and 'down' and 'heavy' and 'light' apply equally and independently to the two opposite places, centre and circumference, in virtue of the two elements which are located there, fire at the circumference and earth at the centre. For the conclusion of Plato's analysis is that the movements of fire at the circumference and the movements of earth at the centre are both of them to be described in terms of 'up' and 'down' and of 'heavy' and 'light' (63A6-D4).

Hence the paradox (63D4-E3). According to the common error—our 'settled ways of thinking' (cf. *εἰθίσμεθα*, 63A7)—each term in the oppositions of 'heavy' and 'light' and of 'up' and 'down' has a *single and exclusive reference*, since each term is related to one only of the two opposite places which 'divide the whole between them' (cf. 62C5-6). But according to Plato's new and paradoxical interpretation the same term in each opposition must have a *different and opposite reference*, depending on whether it is used in relation to centre or to circumference. Hence 'what is light in one place is the opposite of what is light in the opposite place' (cf. 63D6-7).

(v)

I conclude therefore that Plato has *retained* in effect that feature of the common error whereby there are 'by nature two opposite places which divide the whole between them' (62C5-6), but that he has *abandoned* the assumption embedded in the common error whereby this opposition of place is associated in a simple one-to-one relationship with the oppositions of weight and of direction.

Instead, Plato's conclusion has been that the oppositions of weight and of direction are *subordinated* to the opposition of place, in such a way that *both* terms in the opposition of weight, and *both* terms in the opposition of direction, apply equally and independently to *each* term in the opposition of place, with therefore a different and 'opposite' reference, depending on whether they are used in relation to the centre or in relation to the circumference.

§ 3. THE FINAL DEFINITION

Up to this point (63E3), the second part of Plato's argument has progressed as follows.

1. Plato first describes heavy and light and up and down for fire and for earth separately.
2. Plato then joins the two examples in the formula that what is heavy or light, up or down, in one place is the opposite of what is heavy or light, up or down, in the opposite place: what I have called the alignment of opposites.

Plato now concludes his account with a single synoptic definition, which is evidently intended to summarise the true sense of heavy and light and of up and down, in a formula that will apply equally, and jointly, to fire and to earth.

There is one thing, Plato tells us in this final definition, which we must fix our minds upon in all cases: namely that in every instance it is the journey towards its native element which makes a body heavy when it travels thither, and which makes the place towards which such a body travels the place below, 'and conversely for the things that are different to these', 63E3-7: τόδε γε μὴν ἔν τι διανοητέον περὶ πάντων αὐτῶν, ὥς ἡ μὲν πρὸς τὸ συγγενὲς ὁδὸς ἐκάστοις οὕσα βαρὺ μὲν τὸ φερόμενον ποιεῖ, τὸν δὲ τόπον εἰς ὃν τὸ τοιοῦτον φέρεται, κάτω, τὰ δὲ τούτοις ἔχοντα ὥς ἐτέρως θάτερα. Plato then concludes, 63E7-8: περὶ δὴ τούτων αὐτῶν παθημάτων ταῦτα αἴτια εἰρήσθω.

(i)

This final element in Plato's analysis is rather like the image of the man walking round the earth which closes the earlier part of the analysis. Like Plato's earlier image, the final definition can either be taken entirely innocently, as all of a piece with the analysis that has preceded it, or alternatively it can be taken as more like a Trojan horse, which once introduced into the argument can release a whole new stream of ideas that if they are allowed to run free will radically alter the complexion of the argument. For the moment, I take this new element exclusively in its

simpler sense. The complications will be kept for the chapters following this.⁸

If we keep strictly to the examples that have been given, of fire and earth measured at the circumference and at the centre respectively, then the implications of Plato's final definition can be spelt out as follows.

Heavy and down

— Measured from the centre, a larger quantity of earth has a stronger tendency to return to its native element. This tendency determines that the larger quantity shall be reckoned as heavy, and that movement towards the centre shall be reckoned as movement downwards.

— Measured at the circumference, a larger quantity of fire has a stronger tendency to return to its parent body. This tendency determines that the larger quantity shall be reckoned as heavier, and that movement towards the circumference shall be reckoned as movement downwards.

Light and up

— Measured from the centre, a smaller quantity of earth can be lifted more easily. The smaller quantity therefore is lighter, and movement away from the centre is movement upwards.

— Measured at the circumference, a smaller quantity of fire can the more easily be dragged away from its parent body. The smaller quantity therefore is lighter, and movement away from the circumference is movement upwards.

(ii)

Plato's analysis of direction (62C8-63A6) rejected any use of the terms 'up' and 'down' in the description of the cosmos. The analysis of direction and weight (63A6ff.) has introduced a new and paradoxical use of 'up' and 'down' and of 'heavy' and 'light'. This change has been made possible because the universe which had initially been described in purely geometrical terms has now been populated, so to speak, by the elements.

In Plato's new and paradoxical usage, the oppositions of direction and weight do not apply directly to centre or to circumference as such, for this would contravene Plato's description of the 'geometrical' universe; they attach instead to the behaviour of the elements. It is 'the journey of a body towards its native element' (*cf.* 63D4-5), the movement of earth, for example, towards the main body of earth, lying at the centre of the universe, which entitles us to speak of earth as moving 'downwards'.

In this example, when we describe movement towards the centre as movement 'downwards', we do so, not because the centre itself is 'down', but because that is the direction in which earth moves when it travels to join its parent body.

⁸ See esp. pp. 66ff. below.

On the other hand, Plato retains the idea that centre and circumference are opposed: the elements, especially fire and earth, occupy each an 'opposite' place in the universe (cf. *τόπον ἐναντίον*, 63D6). It follows therefore that both terms in the oppositions of weight and of direction have each a different and 'opposite' reference, when applied to the movements of fire at the circumference and when applied to the movements of earth at the centre. Hence the paradoxical formulation of the alignment of opposites: 'what is light in the one place is the opposite of what is light in the opposite place' (cf. 63D6-7).

At the cost of this paradox, Plato is enabled to give a unified definition (cf. *ἐν τι διανοητέον* ..., 63E3-4) of the behaviour of earth and of fire, and to explain how 'these things have come to be named as they are' (cf. *ὅθεν δὲ ὠνομάσθη ταῦτα*, 63A6). 'Heavy' and 'light' and 'up' and 'down' apply not (as most people assume, and as Aristotle will claim) to opposite places in the universe, but to the behaviour of the elements, to the movements of portions of fire and earth towards or away from their parent body.

(iii)

I conclude that Plato retains the assumption of the 'common error', whereby 'opposite places divide the whole between them' (62C5-6), and even that he continues to attach to this opposition of place the use of opposite 'names', heavy and light and up and down, but that he does so only through the mediation of the elements.

It is the behaviour of the elements which provides directly for the continued use of 'heavy' and 'light' and of 'up' and 'down'. The opposition of centre and circumference is related not directly to either opposition, but yields instead the paradoxical conclusion that when these names are applied to the movements of earth at the centre they will have an opposite reference to the use of those same names when applied to the behaviour of fire at the circumference.

Is so much all too obvious? I will only warn the reader, who has perhaps been already over-persuaded by my account, and who may already be impatient with this laborious re-statement of what he may think is already clear enough in Plato's text, that most major modern writings on the *Timaeus* contain another, and quite different, account of Plato's meaning.

§ 4. TRANSLATION

I conclude this preliminary survey of Plato's later theory of weight with a translation which deliberately includes some elements of paraphrase, 62C3-63E8:

Introduction

“‘Heavy’ and ‘light’ may be explained most clearly if the pair is scrutinized in conjunction with the nature that people attribute to ‘down’ and ‘up’.

*The analysis of direction**The common error*

‘For the belief that in the nature of things there are two regions which divide the whole between them, and which are opposite to one another: the one of them “down”, to which everything is carried that has any kind of body or bulk, and the other, the place “above”, to which things move only against their wishes; such a belief is totally misguided.

Plato’s own definition

‘Granted that the whole universe is spherical in shape, then:

Circumference

‘The parts of the whole that are set out from the centre an equal distance, and that are thereby established as extremities, must needs be constituted by nature as all to the same degree and in the same sense extreme.

Centre

‘The centre is set away the same distance from the extremities, and must therefore be reckoned as in the opposite position to them all.

Irrelevancy of ‘up’ and ‘down’

‘Granted then that the cosmos is constituted by nature in this manner: in that case, which of the parts we have mentioned could one possibly designate as being “above” or “below” without seeming, and justly so, to be applying to them a name which has no relevance to them at all?

Centre

‘The central region in the cosmos has no right to be called by nature “below” or “above”. It is simply itself in the centre.

Circumference

‘The circumference can hardly be central, nor does it have any one part of itself different from any other in being related to the centre more closely than any one of the parts which are opposite to it.

The central body and the cosmic traveller

‘Granted therefore that the cosmos is constituted by nature as alike in all directions: then what kind of names of opposites could we possibly apply to it, and how, by the use of such names, could one possibly consider oneself to be speaking sensibly or appropriately about it?

‘Let us make a further supposition (καί, 62D12): imagine that a central body were poised in the middle of the whole.

Circumference

‘It would never travel towards any one of the extremities, because they would be, in every direction, all exactly the same.

Centre

'Now further: if someone could walk round and round this body, he would find himself constantly coming round to a position the other way up from the way he was before. He would therefore be led to call one and the same part of the body "down" and "up".'

Conclusion

'Thus if, as I stated at the outset, the whole universe is spherical, then to claim that one region in it is "below", and that another region in it is "above", can only show a lack of understanding.

*The analysis of weight**The solution to the problem of 'up' and 'down'*

'But how it comes about that these places were called as they are, and what it is in the way they are now that has accustomed us, because of them, to carve up the universe, the whole of it, into two segments and to call it as we do now, <one half "above" and the other half "below">: these are points that can be happily settled, if we are willing to allow the following suppositions.

Fire measured at the circumference

'Imagine someone in the region of the universe to which fire especially has been allotted, and where there would be accumulated the main body to which fire moves.

'Our friend climbs up onto this mass of fire, and we must then imagine him as able to scoop out individual portions of fire and put them into either side of a balance and weigh them.

'As he lifts the beam of the balance, and pulls the fire into the alien air, he will have to use a certain amount of force. As he does so, it will clearly be the smaller quantity, or so we must suppose ($\pi\omega\nu$, 63C1), which will yield to force more easily than the larger quantity.

'For provided that the same effort is used to raise both portions of fire at the same time, then presumably, as either body answers to the strain ($\chi\alpha\tau\alpha\tau\epsilon\iota\nu\acute{o}\mu\epsilon\nu\omicron\nu$, 63C3), the smaller body must be more likely, and the larger body must be less likely, to follow the force exerted upon it.

'Thus the large quantity must be called "heavy", and must be spoken of as travelling "downwards", while the small quantity must be called "light", and be spoken of as travelling "upwards".'

Earth measured at the centre

'This is the very thing that we need to catch ourselves out doing in the region of the universe that we actually live in.

'We stand on earth, and we try to distinguish different kinds of things that are made of earth, or even on occasion lumps of actual earth. What we do in effect, is drag them by force, against their natural inclination, into the alien air. Both pieces of earth, or whatever it is, try to cling to the substance that they belong to: but the smaller piece gives way more easily than the larger one to the force that we exert upon it, and is the first to follow into the alien environment.

‘Consequently, we designate the smaller piece as being “light”, and we refer to the place that we force it towards as being “up”, while behaviour of the opposite kind we describe by the terms “heavy” and “down”.

The alignment of opposites

‘From this it follows inexorably that the terms in question are at variance, since the masses of the two kinds of element are directly opposed to each other in the positions that they occupy.

‘Thus what is heavy or light or up or down in one place will in every case be found to become and to be the opposite of what is heavy or light or up or down in the opposite place: and to be inclined at opposite angles, and indeed to be different in every possible way.

The final definition

‘So then, there is one thing that must be kept in mind in all these cases, and it is this.

‘For every body, the journey towards its native element makes the body as it travels thither “heavy”, and makes the place towards which such a body travels the place “below”, while “light” and “above” are used when things are the other way round.

Envoi

‘So much therefore for the explanation of how heavy and light affect us.’

CHAPTER THREE
THE MODERN EXTENSION

§ 1. TAYLOR'S INTERPRETATION

So far, one virtue of my analysis lies in what has *not* been said.

Consider Taylor's interpretation, which is more explicit and more detailed than that of Cornford at this point, and which Cornford allows to pass without correction.

'We are now', in arriving at Plato's account of the alignment of opposites (63D4ff.), 'in a position to formulate the general principle implied in the two cases just examined. We see that what is "light"—easy to dislodge—in one region is "heavy", hard to dislodge in another. Anything is easy to dislodge from an "alien" region in the direction of its own, and the more there is of it, the less effort is required for its expulsion. Anything is hard to dislodge from its own proper region, and the more there is of it, the harder the task is. And by what is "light" or "heavy" in a given region we mean what is easy, or hard, to dislodge.'

Later:

'That is heavy which it is hard to shift into a foreign region, that light which is easy to shift. Hence we, who live on earth, call earth heavier than fire or air, and a big stone heavier than a small one. But if we lived in the region of fire we should find it much easier to expel earth from our neighbourhood than fire, and easier—*it is assumed*—to expel a big stone than a small one. So we should then call fire heavier than earth and, *I suppose*, a small stone heavier than a large one. The key to the whole doctrine is to understand that to an observer anywhere in the universe "up" means out of his own "region" into the adjacent region' (all the italics are mine).¹

At first glance, this interpretation may look like a seamless, and a sensible, whole. But it is in fact crucial to observe how much in Taylor's commentary comes from Plato, and how much from Taylor's own imaginings—stimulated, as we shall see, by his memories of Aristotle and of Theophrastus.

(i)

Plato has told us that:

1. Measured from the centre, a large quantity of earth is heavy and a small quantity light (esp. 63C5-D4).

¹ Taylor, *Commentary* 440-1.

2. Measured from the circumference, a large quantity of fire is heavy and a small quantity of fire is light (esp. 63B2-C5).

Plato has *not* told us, as Taylor tells us in the second passage I have quoted, that:

1. Measured from the centre, earth is heavier than fire. ('We, who live on earth, call earth heavier than fire or air.')
2. Measured from the circumference, fire is heavier than earth. ('If we lived in the region of fire ... we should then call fire heavier than earth.')

Equally Plato has *not* told us, as Taylor tells us, that:

1. Measured from the centre, a large quantity of fire is light and a small quantity heavy. (This is clearly implied in the first passage.)
2. Measured from the circumference, a large quantity of earth is light and a small quantity is heavy. (This is made explicit in the second passage: 'If we lived in the region of fire ... we should then call ... a small stone heavier than a large one.')

For Plato deals explicitly with only two possibilities:

1. The measurement of different quantities of earth at the centre.
2. The measurement of different quantities of fire at the circumference.

Plato does *not* describe explicitly any circumstance other than these two.

1. He does *not* describe the comparison of earth with fire at the centre, *nor* the comparison of fire with earth at the circumference.
2. He does *not* describe the comparison of different quantities of fire at the centre, *nor* the comparison of different quantities of earth at the circumference.

It is solely through a desire to extend and to complete Plato's theory that Taylor takes into account these further possibilities.

(ii)

In attempting to complete Plato's theory, Taylor makes two pairs of suppositions.

Comparison of different elements

1. Measured at the centre, earth is heavier than fire.
2. Measured at the circumference, fire will be heavier than earth.

Comparison of different portions of the same element

1. Taylor clearly intends us to suppose, especially in the first passage I have quoted, that measured at the centre the larger quantity of fire will be lighter and the smaller quantity will be heavier.

2. Taylor states explicitly that measured at the circumference a larger quantity of earth will be lighter and a smaller quantity will be heavier: 'a small stone' will be 'heavier than a large one'.

I have already stressed that neither pair of comparisons is in fact described explicitly by Plato. Taylor has added his comparison of 'earth' with 'fire or air', and his illustration of the 'big stone' measured at the circumference, simply in order to complete Plato's theory. What is revealing is that in doing so Taylor draws on Aristotle's theory. For Taylor ascribes to the measurement of fire and earth at the centre (the *first* member in each of the two pairs of comparisons which I have listed) precisely the features which Aristotle ascribes to fire and to earth, independently of the qualification of place.

Comparison of different elements

For Aristotle: earth, in no matter how small a quantity, is heavier than fire, in no matter how large a quantity.

Comparison of different portions of the same element

For Aristotle: a larger quantity of fire is invariably lighter than a smaller quantity, in that it will travel upwards more quickly.²

(iii)

The suspicion of Aristotelean influence must be the greater since, even from the parts of Taylor's note which I have quoted, it is clear that his interpretation rests not on evidence and argument, but on intuition, or to put it less kindly on a series of unthinking assumptions.

Thus at the beginning of the long note from which my first quotation is taken, Taylor simply takes for granted that whatever principle is entailed by Plato's account of fire and earth will apply to *either* element in *either* position, i.e. to fire at the centre as well as at the circumference, to earth at the circumference as well as at the centre.

² This is the theory of weight which I shall seek to establish in my third and fourth essays: see esp. *De caelo* iv 4, 311a15ff. In comparing Aristotle and Taylor, I leave aside the point that although Aristotle thinks a larger quantity of fire is lighter than a smaller quantity, he does not think that the smaller quantity is therefore 'heavier', only that it is less light. This and other refinements of Aristotle's theory will be explored in my third and fourth volumes.

It may seem unnecessary to claim Aristotelean influence for Taylor's belief that earth, at the centre, is heavier than fire. But when Taylor writes that 'we, who live on earth, call earth heavier than fire or air ...', he seems to assume that earth, at the centre, is inherently heavier than fire or air, i.e. independently of the quantities compared; this comes close to the specifically Aristotelean belief in the 'absolute' heaviness of earth.

It is only in the second passage I have quoted, taken from towards the end of the same note, when he comes to take an actual example, of a large stone and a small stone measured at the circumference, that Taylor shows any sign, in the phrases I have italicised, of being conscious that he is stepping beyond Plato's own statement of his theory.

But at this point Taylor obviously feels himself so confidently launched upon his interpretation of Plato's theory that he is unable to call a halt, as it were, and to ask himself precisely how much he has already added to the text of Plato, or precisely what the credentials are for his re-statement, and expansion, of Plato's theory.

It is for us, therefore, to stand back and to consider what truth or likelihood, if any, there may be in the various elements of Taylor's interpretation, and what evidence, if any, there may be for them.

In particular, we need to distinguish, from the outset, between two quite different elements in Taylor's expansion and 'completion' of Plato's theory.

1. The comparison of earth with fire at centre or circumference.
2. The comparison of earth with earth at the circumference, and the comparison of fire with fire at the centre.

(iv)

The *first* element in Taylor's interpretation, the question of there being a comparison between *different elements* at centre or circumference, can be dealt with fairly summarily, at least for the moment.

Plato gives no indication at all that his present analysis is designed to include a comparison, in terms of heavy and light, between different elements, fire and earth. The only examples which are made explicit in Plato's text are restricted to a comparison between different quantities of the same element, whether it be different quantities of earth (at the centre), or different quantities of fire (at the circumference).

It is true, the absence of an explicit comparison between different elements in Plato's analysis of weight and direction will prove, as I believe, to be a major deficiency in his theory as a whole, and one which can be explained, if at all, only when we come to look back at the present passage in conjunction with the definition which Plato offers earlier in the *Timaeus*, of weight as defined by number, where Plato's comparison does lie between different elements.³

³ For my explanation, see pp. 210-15 and 304-11 below. I postpone the problem again, p. 156 below. Here as later (pp. 125-7 below), in denying that Plato's present theory of weight includes a comparison between different elements, I do not of course mean to exclude the comparison, or rather the *contrast*, between elements which are measured in *dif-*

For the moment therefore I note only the fact: Plato has no explicit comparison, in this later passage, of fire with earth, as measured at the centre or at the circumference. Taylor's whole account of how 'we, who live on earth, call earth heavier than fire or air', and of how, if we lived in the region of fire, 'we should then call fire heavier than earth', is a choice example of the worst kind of commentator's gloss—the addition of materials, wholly extraneous to the text, which the commentator has unreflectingly added from his own cogitations, but which then seem to him so totally obvious that he never for one moment thinks to verify them by reference to the words that he has before him.

Unhappily, the study of classical philosophy is littered with glosses of this kind: some trivial, some crucial; some merely transitory, others deeply embedded in the exegetical tradition; all of them, a standing affront to the powers of the critical intelligence to attend to the words that someone else has uttered, without at once flooding those words with alien preconceptions and its own presuppositions.

(v)

The *second* feature of Taylor's interpretation, the question of an extension of the comparison between different quantities of *the same element*, so that different quantities of earth are measured at the circumference, and different quantities of fire at the centre, is more problematical.

According to Taylor:

1. A larger quantity of earth is heavier when measured at the centre, and lighter if measured at the circumference. ('We, who live on earth, call ... a big stone heavier than a small one. But if we lived in the region of fire ... we should then call ... a small stone heavier than a large one.')

2. A larger quantity of fire is heavier when measured at the circumference, and lighter if measured at the centre. (This is clearly implied in the first passage I have quoted from Taylor's commentary.)

I have already stressed that neither comparison finds a place in Plato's text. On the other hand, it could be said that, at least at first sight, this

ferent places, as when Plato writes that 'what is heavy in one place is the opposite of what is heavy in the opposite place', where the meaning, I have so far argued, is that a large quantity of fire measured at the circumference is the opposite of a large quantity of earth measured at the centre (63D4-E3: ch. II § 2, pp. 35-9 above). My point is that the two examples which Plato has chosen in order to exemplify his analysis are designed to compare fire with fire at the circumference (63B2-C5) or earth with earth at the centre (63C5-D4): in *neither* case are we invited to compare fire with earth *in the same place*.

part of Taylor's interpretation provides a possible, even a plausible, elaboration of the circumstances which Plato actually describes.

I shall argue that, plausible though this feature of Taylor's interpretation may seem at first sight, it cannot be the interpretation which Plato himself intended. For if we do decide to extend the comparison between different quantities of the same element, to include the calculation of fire at the centre and of earth at the circumference, then Plato's final definition, I shall argue, requires us to adopt the *opposite* conclusion to that of Taylor.

1. A larger quantity of earth will be reckoned as heavier than a smaller quantity, if it is measured at the circumference, no less than if it is measured at the centre.

2. A larger quantity of fire will be heavier than a smaller quantity, if it is measured at the centre, no less than if it is measured at the circumference.⁴

(vi)

From this it does not follow that Plato did in fact intend to extend the comparison between different quantities of the same element, to include the measurement of fire at the centre and of earth at the circumference. There are two distinct issues.

1. *Whether* Plato intended to extend his theory to include the measurement of fire at the centre and of earth at the circumference.

2. If Plato intended to extend his theory in this way, then *how* he intended to do so.

It is the more important to distinguish these two issues because the evidence does not allow us to handle them in the way which logically would be simpler: to try to decide first *whether* Plato intended to extend his theory; and only if we decide that he did mean to extend his theory, then to consider *how* he may have intended to do so.

For I shall argue that Plato's final definition helps us to decide *how* we are to extend the theory, if we are going to do so, but indicates less clearly *whether* Plato ever meant to extend his theory in this way at all. Indeed my conclusion will be that the way in which the theory would have to be extended, to conform to Plato's own expressed convictions, may have been a significant factor in keeping Plato from facing squarely the question of the precise scope of his theory.⁵

⁴ The point is developed, pp. 56ff. and 70ff. below.

⁵ The earlier history of what I have called here Taylor's interpretation, and a list of other more recent writers who have adopted this same account of Plato's theory, is given separately in Note 3, pp. 327-40 below.

§ 2. THE FALSE ANALOGY

Taylor's note is attached to what I have called the alignment of opposites, Plato's assertion that 'what is light in one place is the opposite of what is light in the opposite place' (63D4-E3).

Taylor apparently takes this to mean, or to imply, that what is light in the one place will be *heavy* in the opposite place. Since 'heavy' and 'light' are defined respectively as 'difficult to move' and as 'easy to move', it will follow that a small quantity of earth, for example, which is 'light', and therefore easy to move, at the centre, will be 'heavy', and therefore difficult to move, at the circumference.

Hence Taylor's conclusion, in the passage already quoted, that 'if we lived in the region of fire, we should find it ... easier ... to expel a big stone than a small one.'

On this interpretation, the point—or the implication—of Plato's formulation is that *the same body* which is light at the centre will be heavy at the circumference, and *vice versa*, and therefore that earth which is measured at the centre is also measured at the circumference, and that fire which is measured at the circumference is also measured at the centre.

On the interpretation which I have proposed, *different bodies* are compared at centre and at circumference, and there will be no comparison of fire at the centre or of earth at the circumference.

The meaning and the implication of Plato's formulation will be simply that a larger and a smaller quantity of earth at the centre are 'opposite' respectively to a larger and a smaller quantity of fire at the circumference, since centre and circumference are opposed, and what is easier or more difficult to move away from the centre is therefore deemed to be 'opposite' to what is easier or more difficult to move away from the circumference.

This difference of interpretation will be crucial to an understanding of Plato's theory as a whole, and in particular to an understanding of the criticisms which Theophrastus will make of Plato's theory. We shall need therefore to look at Taylor's interpretation from several points of view. I have already suggested that Taylor's reading of the *Timaeus* springs in large part from his infiltrating into Plato's text ideas that are Aristotelean in origin. But the foothold which Taylor needs, in the text of the *Timaeus*, for his Aristoteleanising interpretation of Plato, is to be found, I suggest, in a false analogy between the oppositions of weight and of direction.

(i)

Thus in order to loosen the soil around the roots of Taylor's interpretation I suggest that we start by considering not the opposition of weight but the opposition of direction.

In my account of the alignment of opposites, I defined 'up' and 'down' as meaning towards and away from centre or circumference, depending on the position of the observer. This is sufficient to give immediate sense to Plato's formula that what is 'up' in one region, say away from the centre, when viewed from the centre, is the opposite of what is 'up' in the opposite region, i.e. away from the circumference, when viewed from the circumference.

At the same time, 'up' defined at the circumference is of course also opposed to 'down' defined at the circumference. We may think therefore to conclude, from Plato's statement of the alignment of opposites, that:

1. What is 'up' in one region, for example away from the centre, if we are stationed at the centre, will be the *opposite* of what is 'up' in the opposite region, i.e. away from the circumference, if we are stationed at the circumference.
2. It will therefore be the *same* as what is 'down' in that same region, namely towards the circumference.

From this we may think it would follow that a single body, in moving from the centre to the circumference, will exemplify both oppositions in the course of its journey. We may think to argue that it will move 'up', in so far as it moves away from the centre, and that it will move 'down', in so far as it moves towards the circumference, at least as viewed by two different observers, stationed at the centre and at the circumference.

It is in fact clear that Taylor has followed something of this line of reasoning, when he writes that:

'The terms "up" and "down" are purely relative to the position of the observer who uses them. For example, we should think of Jules Verne's adventurers as shot *up* to the moon, but the "man in the moon" would think of them as *descending* on his planet.'⁶

This extends 'away from the centre' to mean 'towards the circumference', with a single body therefore exemplifying movement *both up and down*, in the course of its journey from centre to circumference, precisely as in the account I have just given.

(ii)

Once we have interpreted differences of direction in this way, then we may expect to give an analogous account of differences of weight.

1. We may think to argue that what is heavy in one region, say a large quantity of earth at the centre, will be the *opposite* of what is

⁶ *Commentary* 440.

heavy in the opposite region, i.e. a large quantity of fire at the circumference.

2. Therefore at the same time—we may think—it will be the *same* as, or equivalent to, what is *light* in that same region.

Hence we may conclude that a large quantity of earth, which Plato tells us is heavy at the centre, will be light at the circumference, and therefore that the body which is more difficult to move at the centre will be easier to move at the circumference, and *vice versa*.

This is of course again exactly Taylor's conclusion. 'What is "light" ... in one region is "heavy" ... in another.'⁷ Therefore, 'if we lived in the region of fire ... we should then call ... a small stone heavier than a large one.'⁸ This makes differences of weight exactly analogous to differences of direction, precisely as in the account which I have just outlined.

Indeed it is, I suspect, largely the force of this analogy between weight and direction which makes it possible for Taylor to move as easily as he does from the picture of Jules Verne's adventurers 'descending' on the moon to the comparison between the large stone and the small stone measured at the circumference.

(iii)

Now this analogy of weight and of direction I believe is falsified by Plato's final definition (63E3-7). But for the moment all I would wish to point out is that even in itself Taylor's elaboration of the analogy of weight and direction, if I have uncovered it aright, is much less compelling than may at first sight appear.

Up to and including Plato's account of the alignment of opposites (63D4-E3), it would be legitimate to suppose that 'up' and 'down' are used to mean simply away from the centre or circumference and towards the centre or circumference respectively, dependent upon the position of an observer. Taylor therefore concludes apparently that a body which moves from centre to circumference would at first be reckoned as travelling 'up', in the sense of moving away from the centre, and would then be reckoned as travelling 'down', in the sense of travelling towards the circumference. This, at least, would seem to be implied in Taylor's account of Jules Verne's adventurers 'descending' on the moon.

But even if we allow this analysis for the difference of direction, it does not follow that we can argue analogously for the difference of weight. If

⁷ *Commentary* 440.

⁸ *Commentary* 441.

we imagine earth, for example, moving away from the centre, and continuing to travel towards the circumference, we cannot tell, at this stage in Plato's analysis (i.e. up to and including the alignment of opposites, 63E3), whether in travelling 'down' to the circumference it will be reckoned as heavy or as light.

For the only body whose behaviour Plato has described for us at the circumference is fire: a smaller quantity can be moved away from the circumference more easily, and is therefore light, a larger quantity would be more difficult to move, and must therefore be reckoned as being heavy. If we now try to imagine a quantity of earth as moving towards or away from the circumference, we simply have no means of knowing, from the circumstances which Plato has chosen to describe, whether the larger quantity would be more easily moved away from the circumference than a smaller quantity, or *vice versa*.

For the point is that in order to know whether a body exemplifies the definition of direction, as dependent upon the position of an observer at the centre or at the circumference, we need know only that a body moves to or from a certain place. But in order to know whether a body exemplifies the definition of weight, we need to know not only that it moves to or from a certain place, but *how* it does so: whether easily, or with difficulty. And that we have no means of knowing, from the course of Plato's analysis up to this point (63E3), in the case of fire measured at the centre or of earth measured at the circumference.

Simple, therefore, and natural though it may appear to extend and so to 'reverse' the account of direction, so that what travels 'up' from the centre, if it continues its journey, will move 'down' to the circumference, it does not follow, even so, that by analogy what is light at the centre will be heavy at the circumference, and *vice versa*.

(iv)

It does not follow, but may it not be true?

Precisely because we have no means of knowing whether a larger quantity of fire will be easier or more difficult to move away from the centre—or whether a larger quantity of earth will be easier or more difficult to move away from the circumference—it becomes possible, up to and including Plato's account of the alignment of opposites (63D4-E3), to imagine that the larger quantity of either element would be easier to move in the region opposite to its own, the more so if we are familiar with Aristotle's doctrine, where a larger quantity of fire does indeed move more quickly from the centre to the circumference, while the smaller

quantity moves—or is moved—more quickly from the circumference towards the centre.⁹

For the element of abstraction and therefore of ambiguity in the expressions ‘what is heavy’ and ‘what is light’ does leave room for two possible exemplifications, at the centre and at the circumference.

‘What is heavy’

1. Plato tells us only that a larger quantity of fire is more difficult to move away from the circumference, and that a larger quantity of earth is more difficult to move away from the centre.

2. But we may also imagine that, as in Aristotle’s theory, a smaller quantity of fire would move more slowly away from the centre, and that it would therefore be more difficult to move, and that a smaller quantity of earth would therefore likewise be more difficult to move away from the circumference.

‘What is light’

1. Plato tells us only that a smaller quantity of fire is easier to move away from the circumference, and that a smaller quantity of earth is easier to move away from the centre.

2. But we may also imagine that, as in Aristotle’s theory, a larger quantity of fire would move more quickly away from the centre, and that it would therefore be easier to move, and that a larger quantity of earth would therefore likewise be easier to move away from the circumference.

My present claim therefore is not that this whole elaboration of Plato’s theory is impossible, at this stage in Plato’s analysis (up to 63E3), but simply that, contrary to what Taylor appears to assume, the alternative exemplifications of ‘what is heavy’ and of ‘what is light’ do not follow from, and are in no way directly supported by, the analogy which Plato obviously does intend to provide between weight and direction.

Plato has described only the behaviour of fire at the circumference and of earth at the centre. The *second* set of exemplifications under either heading follows only if we imagine a circumstance which Plato himself has *not* described, the measurement of earth at the circumference and of fire at the centre, and if having done so we then interpret this circumstance in a particular way, whereby the larger quantity of either element is easier to move in the place which is opposite to its own.

(v)

This is in part the Aristotelean assumption, and it is, I have already suggested, probably the influence of Aristotle’s ideas which leads Taylor

⁹ These two principles are stated at *De caelo* iv 2, 308b18-21: significantly, in opposition to Plato’s theory. The place of the two principles in Aristotle’s own theory I shall consider in my third volume. For their use in Aristotle’s *criticism* of Plato see ch. X § 2, pp. 199-210 below.

to adopt the interpretation that he does, while equally it is, I suspect, the ambiguity resulting from the inevitable degree of abstraction in the expressions 'what is heavy' and 'what is light', coupled with a superficial reading of the analogy between the analyses of weight and direction, which gives Taylor the opening that he needs in the text of the *Timaeus* in order to be able to graft his Aristoteleanising interpretation onto Plato's analysis of weight as a whole.

That interpretation has not yet been shown to be false. I hope only to have shown that it is unnecessary. The immediate sense of Plato's account of the alignment of opposites is sufficiently exemplified by the two examples of fire as measured at the circumference, and of earth as measured at the centre, as I outlined in my earlier analysis. From the formulae which Plato offers for the alignment of opposites, we cannot be sure whether Plato intends to extend his theory to include fire measured at the centre, and earth measured at the circumference; nor, if he does intend to do so, can we tell how he intends to do so.

§ 3. PLATO'S CORRECTIVE

When we turn to Plato's final definition, we find positive evidence that Taylor's interpretation, and in particular the analogy of weight and direction which appears to underly Taylor's interpretation, cannot be what Plato intended.

In his final definition (63E3-7), Plato states that 'the journey of a body towards its native element makes the body which travels thither heavy, and a body travelling in such a direction must be reckoned as moving downwards.' He adds: 'To things that are the other way round, we give the opposite names.'

In my initial analysis, I explained this as meaning that:

1. The larger quantity of fire, or of earth, has a stronger tendency to return to its parent body: this tendency determines that the larger quantity shall be heavier, and that movement towards the circumference, for fire, or towards the centre, for earth, shall be reckoned as movement downwards.

2. A smaller quantity of fire, or of earth, can the more easily be dragged away from its parent body: the smaller quantity therefore is lighter, and movement away from the circumference, for fire, or away from the centre, for earth, is therefore reckoned as movement upwards.¹⁰

¹⁰ Cf. ch. II § 3, pp. 39-41 above.

If we are now to extend Plato's final formula, to include the movement of fire to and from the centre, and of earth to and from the circumference, then we find that it cannot lead to Taylor's interpretation.

(i)

According to Taylor, in the final sentence which I quoted from his commentary:

'The key to the whole doctrine is to understand that to an observer anywhere in the universe "up" means out of his own "region" into the adjacent region.'¹¹

Further, according to Taylor, in a sentence which I quoted earlier:

'The terms "up" and "down" are purely relative to the position of the observer who uses them. For example, we should think of Jules Verne's adventurers as shot *up* to the moon, but the "man in the moon" would think of them as *descending* on his planet.'¹²

On Taylor's interpretation, it follows therefore that a portion of earth, for example, which moves from centre to circumference, will be travelling *upwards* from the point of view of an observer at the centre, and *downwards* from the point of view of an observer at the circumference.

But earth which is moving from centre to circumference is all the time travelling away from its native element. Therefore, according to Plato's final definition, it is travelling simply *upwards*.

If we are to extend the theory of the *Timaeus* at all, then Plato's final definition requires us to adopt the opposite conclusion to that taken by Taylor. Since Plato tells us explicitly that 'up' and 'down' are to be determined by the movement of a body away from, or towards, its native element, then earth must be reckoned as travelling *upwards*, whether it is moving away from the centre or towards the circumference, and as travelling *downwards*, whether it is travelling away from the circumference or towards the centre.

Similarly, fire must be reckoned as moving *upwards*, whether it is travelling away from the circumference or towards the centre, and as moving *downwards*, whether it is travelling away from the centre or towards the circumference.

Thus Jules Verne's travellers 'descending' on the moon present precisely the opposite conclusion to that which Plato has intended. Earth which moves from centre to circumference does not exemplify two directions in the course of its trajectory, *both* 'up' and 'down'. According to the

¹¹ *Commentary* 441.

¹² *Commentary* 440.

terms of Plato's final definition, earth which moves from the centre to the circumference will have to be reckoned as moving always, and only, upwards.

(ii)

Something the same must be true of weight. According to Plato (63E3-7): 'the journey towards its native body makes a body which travels thither heavy.'

In my initial analysis of Plato's argument, I noted that, according to the examples which Plato has given, this must mean, whatever else it may mean or imply, that a larger portion of fire or of earth, measured respectively at the circumference and at the centre, will have a stronger tendency to move towards its parent body, and will therefore be reckoned as heavier than a smaller portion of the same element, which Plato has told us will be easier to move away from its parent body, and will therefore be reckoned as lighter and as moving upwards.

If we now consider Plato's final formula as it *might* apply to fire measured at the centre, or to earth measured at the circumference, we find that it cannot lead to Taylor's interpretation.

According to Taylor:

'By what is "light" ... in a given region we mean what is easy ... to dislodge.'

Further, according to Taylor:

'If we lived in the region of fire we should find it much easier to expel earth from our neighbourhood than fire, and easier—it is assumed—to expel a big stone than a small one.'¹³

On Taylor's criterion, the 'big stone' will therefore be *lighter*.

But earth which is moving away from the circumference will be 'travelling towards its native element.' Therefore, according to Plato's final formula, it should be *heavy*.

The same considerations apply to fire. On Taylor's interpretation, a large quantity of fire would presumably travel away from the centre more easily, and would therefore be *lighter*. But fire which is moving away from the centre will be 'travelling towards its native element'. Therefore, according to Plato's final formula, it should be *heavy*.

Thus if we are to extend the theory of the *Timaeus* to include the circumstance which Taylor has chosen to describe, then Plato's final definition again requires us to adopt the opposite conclusion to the one adopted by Taylor.

¹³ *Commentary* 440-1.

If the journey towards its native element makes a body which travels thither 'heavy', then earth must be reckoned as *heavy* whenever it travels towards the *centre* of the universe, no matter whether we imagine it starting its journey from near the centre or from the circumference.

Fire likewise must be *heavy* whenever it travels towards the *circumference* of the universe, no matter whether it starts its journey from near the circumference or from the centre.

If therefore we are to follow Plato's own formula, and if we are to apply it to fire measured at the centre and to earth measured at the circumference, then the conclusion will have to be that a larger quantity of either element is heavy, both when it is measured at the centre and when it is measured from the circumference, provided that, in either case, it is travelling towards its parent body.

(iii)

I conclude that Plato cannot have intended the reader to extend the analysis of weight and direction in the way that Taylor has done. Jules Verne's adventurers 'descending' on the moon are not only an obtrusive gloss; the principle they are intended to illustrate is clearly excluded by the terms of Plato's final definition.

If we are to extend Plato's analysis of direction, then a body moving from centre to circumference will *either* be returning to its native element (fire), and so must be reckoned as moving downwards, *or* it will be moving away from its parent body (earth), and so must be reckoned as moving upwards. What we can no longer envisage, once we have reached Plato's final definition (63E3-7), is that the same body should be reckoned as moving *both* up *and* down in the course of a single trajectory from centre to circumference.

Something the same must be true of weight. A larger quantity of earth expelled from the circumference and a larger quantity of fire expelled from the centre are both alike returning to their parent body. According to Plato's final definition, both bodies must therefore be reckoned as moving downwards and as heavy. Taylor's conclusion that both bodies are *lighter* is excluded by the terms of Plato's final definition.

§ 4. A SECOND IMPASSE

Does it then follow that Plato means us to adopt the 'corrected' version of Taylor's extension to the theory?

Are we to conclude that the final definition is intended by Plato to embrace the measurement of earth at the circumference and of fire at the

centre, but that both elements, in moving away from a region other than their own, are to be reckoned as 'heavy' and as moving 'downwards'?

This conclusion will undoubtedly appeal to many readers, simply because it requires the least possible adaptation to the traditional interpretation of the *Timaeus*.

We retain, on this view, Taylor's assumption that Plato must mean to provide an all-embracing definition of weight, i.e. one which will be designed to include the measurement of either element at both the centre and the circumference of the universe. All we have to do, on this 'corrected' reading of the theory, is adapt the measurement of an element in a place other than its own more closely to the precise wording of Plato's final definition.

I must therefore at once warn the reader that this simple adaptation of Taylor's interpretation to the minimum requirements of the text of the *Timaeus* leads only to a second impasse: to a result hardly more satisfying than Taylor's original 'uncorrected' interpretation.

(i)

According to Taylor's own interpretation, the larger and the smaller stone, 'dislodged' from the circumference, are both moving in the same direction: 'upwards' on Taylor's reading of the theory, since they are moving *away* from the observer at the circumference.

And yet the one stone is to be reckoned as 'heavy' and the other as 'light'. It is therefore no longer true, on this interpretation of the theory, that a body which moves 'downwards' is 'heavy' and that a body which moves 'upwards' is 'light'.

On this interpretation therefore we lose precisely that alignment between weight and direction which to all appearances it has been the major purpose of Plato's elaborate analysis to establish and exemplify, and which is retained most clearly and most forcefully in the final definition.¹⁴

(ii)

But do we fare significantly better on a 'corrected' reading of the theory?

Here, the larger and the smaller stone, moving away from the circumference, are both alike moving towards their parent body, and are therefore to be reckoned, both of them, as moving 'downwards' and as being 'heavy'.

¹⁴ Taylor is in fact inconsistent in his interpretation of 'up' and 'down', 'heavy' and 'light', in relation to the observer and in relation to the element: see below Note 3, esp. pp. 337-9.

This no longer offends the letter of Plato's final definition; but it hardly seems to answer better to the spirit of it. For on this interpretation we lose, not the alignment of weight and direction, but a second feature, hardly less fundamental one would have thought to Plato's analysis: the ability to distinguish between different quantities of a single element, as 'heavy' and 'light'.

(iii)

Indeed the only circumstance which answers at all cleanly and easily to the terms of Plato's final definition is—not the comparison between two bodies moving in the same direction, but—the comparison between two bodies, of the same kind, moving in opposite directions.

And this comparison is to be found—not in Taylor's image of the two stones dislodged from the circumference, however interpreted, but—in the image which has dominated Plato's analysis hitherto: the use of a pair of scales.

When the observer at the centre weighs a larger and a smaller quantity of earth, or when the observer at the circumference weighs a larger and a smaller quantity of fire, then the different quantities of either element move in opposite directions. According to Plato's preceding analysis, the larger body travels downwards and is heavy, the smaller body travels upwards and is light.

This exactly matches the terms of Plato's final definition: the body which travels towards its native element is heavy and moves downwards; the body which travels away from its native element moves upwards and is light.

(iv)

I conclude that Plato's final definition is most easily and most simply read as summarising the use of a pair of scales for measuring different quantities of earth or of fire, at centre and circumference respectively.

The final definition does not apply at all cleanly or easily to the quite different comparison which Taylor has chosen to imagine, of someone attempting to dislodge a larger and a smaller stone at the circumference, even if we give to that comparison the 'corrected' interpretation required by the terms of the final definition.

There are therefore two possibilities: either we must abandon any attempt to measure different quantities of fire at the centre and different quantities of earth at the circumference; or else we must envisage some form of comparison other than that implied by Taylor's comparison of the large and the small stone 'dislodged' from the circumference.

CHAPTER FOUR

THE SCOPE OF THE THEORY

§ 1. ELEMENT AND OBSERVER

We are in the paradoxical position I noted earlier. Plato's final definition (63E3-7) tells us *how* (or at least *how not*) to extend Plato's theory, if we are to include the calculation of fire at the centre and of earth at the circumference. But it is not clear *whether* Plato means to extend his theory in this way at all, since even the 'corrected' extension to his theory is not without its difficulties.

Thus Taylor's own extension to the theory has to be excluded, because it contradicts the terms of the final definition, and since it breaks the alignment between weight and direction which has been one of the chief features of Plato's analysis.

On the other hand, if we 'correct' Taylor's extension, so that it does correspond to the terms of Plato's final definition, then we are left with no obvious means for calculating the difference in weight, between heavy and light, for an element measured in a place other than its own.

And yet the reader may well be reluctant to abandon all claim to universality for Plato's theory. Plato does begin his final definition by telling us that it will apply to 'all these phenomena' (63E3-4: τὸδε γε μὴν ἔν τι διανοητέον περὶ πάντων αὐτῶν ...). Does he mean, nonetheless, to restrict his definition to the measurement of fire at the circumference and of earth at the centre?

It may help to answer this question, if we consider how far an extension to Plato's final formulation, to include the measurement of an element in a place other than its own, would fit in with the general drift of his analysis, and in particular how far it would fit in with the shift in the orientation of Plato's thinking on the question of direction which I outlined earlier.

(i)

Earlier I noted that there were two, potentially discrepant, features in Plato's initial analysis of up and down in a spherical universe, and particularly in his image of the man who walks round the circumference of the central body (62D10-63A6).

1. The description of different parts of the earth, or of different points on the earth's surface, as being in turn up and down, serves, from one point of view, simply to clinch Plato's argument that no

part of a spherical universe can in itself, or 'by nature', be up or down.

2. At the same time, the introduction of a human observer points forward to Plato's analysis of up and down, in conjunction with heavy and light, where the opposition of up and down is given a real, if restricted, meaning.

For in this second part of his analysis (63A6ff.), Plato does not simply repeat the consequences of his earlier image. By introducing an imaginary observer at the circumference of the universe, Plato in effect shifts his earlier opposition, where up and down, at different times, are applied inconsistently to the same part of the earth, or to the same point on the earth's surface, to a fresh opposition where up and down are used to mean towards and away from the centre and circumference independently, and so consistently each with reference to its own region.¹

The point to appreciate is that if we now choose to extend Plato's final definition to include the measurement of fire at the centre and of earth at the circumference, then we must again shift the terms of Plato's opposition: for even the second opposition will now no longer apply in quite the same form.

Fire measured at the centre

1. For an observer at the centre of the universe, in the earlier part of Plato's analysis of direction and weight (63A6-E3), *up* will mean *away* from the centre and *down* will mean *towards* the centre.

2. But for fire, according to Plato's final definition (63E3-7), *up* must mean movement in the direction away from its native element, and therefore movement *towards* the centre, even if it is measured at the centre, while *down* means movement towards its native element, and therefore movement *away* from the centre, even if it is measured at the centre.

Earth measured at the circumference

1. For an observer at the circumference of the universe, in the earlier part of Plato's analysis of direction and weight (63A6-E3), *up* will mean movement *away* from the circumference and *down* will mean movement *towards* the circumference.

2. But for earth, at least according to Plato's final definition (63E3-7), *up* must mean movement in the direction away from its native element, and therefore movement *towards* the circumference, even if it is measured at the circumference, while *down* means movement towards its native element, and therefore *away* from the circumference, even if it is measured at the circumference.

(ii)

This discrepancy arises because in the earlier part of Plato's argument the observers at centre and circumference measure only earth and fire

¹ For this analysis see pp. 30-4 above.

respectively. They can therefore be identified, as it were, with the element in whose region they are stationed.

But if we extend Plato's final definition to include fire at the centre and earth at the circumference, then there can no longer be a simple identification between 'up' and 'down' as they appear to the observer, and 'up' and 'down' as determined by the movement of the element itself.

If we are to extend Plato's definition therefore, then 'up' and 'down' as they appear to an observer at centre or circumference must be *subordinated* to 'up' and 'down' as determined by the movement of either element.

The point will be that we have 'grown accustomed' to thinking of movement away from the earth as movement upwards. But this is in fact true only of earth. If we are to follow the consequences of Plato's final formula rigorously, then for fire movement away from the centre will be movement downwards, because this is the direction in which it travels towards its native element.

There follows an obvious paradox, if we compare the movements of fire and earth.

1. Fire which moves *away* from the centre must be reckoned as moving 'downwards', since it is returning to its like. But earth, in the same region, and to the same observer therefore, will be moving 'downwards' when it moves in the opposite direction, i.e. *towards* the centre.

2. Equally, earth which moves *away* from the circumference must be reckoned as moving 'downwards', since it is returning to its like. But fire, in the same region, and to the same observer therefore, will be moving 'downwards' when it moves in the opposite direction, i.e. *towards* the circumference.

For in Plato's final definition 'up' and 'down' are determined, not by the observer, but by the movement of the element: and up and down will therefore mean different things at the centre, or at the circumference, depending solely on whether the terms apply to the movement of earth or to the movement of fire.

(iii)

Thus if Plato's final definition is to be taken in its extended sense, then the whole analysis of direction will have comprised three stages.

In the first part of Plato's analysis, which deals exclusively with position and direction (62C3-63A6), the conclusion is that neither centre nor circumference can properly be reckoned as being in itself 'up' or 'down'.

In the second part of his argument, where the analysis of direction is joined to that of weight (63A6-E3), Plato tells us initially that 'up' will correctly describe the movement of earth away from the centre and of fire away from the circumference, for an observer in either region respectively, while 'down' will be correctly used to describe the movement of earth towards the centre and of fire towards the circumference, again for an observer in either region respectively.

Finally, if we are to apply Plato's concluding definition (63E3-7) to the measurement of fire at the centre and of earth at the circumference, then the lesson will be that 'up' and 'down' are to be used to describe not the movement of earth and of fire respectively towards or away from centre and circumference, but the movement of either element towards or away from its parent body, with the consequence I have outlined, that fire will be moving 'upwards' and that earth will be moving 'downwards' (or *vice versa*), when both elements will in fact be moving in the same direction (centripetally, in the example quoted).

§ 2. THE NEW OPPOSITION

Strictly, there is no more a contradiction between the *third* element in Plato's analysis and the *second* than there is between the *second* element and the *first*.

As I noted earlier, the apparent discrepancy between Plato's calling the centre *neither up nor down*, and then later using the argument that the same part of a central body would be called in turn *both up and down*, is irrelevant to the immediate purpose of Plato's argument, thanks precisely to the principle found also in the *Phaedo*, that if something has opposite designations then neither designation can belong to it 'by nature'. Nonetheless, in retrospect we see that the positive form of expression in Plato's description of the central body (62D10-63A6), does prepare the way for the positive connotation of direction attached to the analysis of weight (63A6ff.).²

There is a similar ambivalence in Plato's final definition.

(i)

From the simpler point of view, Plato's final definition can be taken as no more than a 'rounding off' of the argument that has preceded: a final formula for weight and direction, but not specifically cast in terms of the position of fire and earth, and so avoiding the superficially paradoxical formulation of 'the alignment of opposites'.

² Cf. pp. 23-7 above.

From this point of view, the observer at centre or circumference can continue to think of movement towards his own position as movement downwards, even though the actual formulation of the final definition enjoins him to think not as it were of himself, but of the movement of the element in whose region he finds himself.

For from this simpler point of view the distinction between element and observer is not a real one, or at least it is not a practical one. For since, on this interpretation, the observer at the circumference thinks only of fire, and the observer at the centre concerns himself only with earth, neither has to make any practical choice between up and down as they appear to him, and up and down as determined by the movement of the element to whose region he belongs.

The synoptic element in Plato's final definition is therefore limited, on this reading, to our putting ourselves, as it were, in the position of being able to appreciate the point of view of both observers, or of each observer in turn, instead of limiting ourselves, as we have naturally become accustomed to doing, to the point of view of the observer who lives on earth.

But from this, the simpler point of view, we do not have to consider the possibility of any conflict of interests, as it were, between the two observers.

On this interpretation, each observer limits himself to his own region, and we—from our synoptic position—do no more than recognise the applicability of the terminology which each observer employs, in relation to his own region, without in any way seeking to impose the terminology of one observer on that of the other: i.e. without seeking to impose the measurement of fire on the observer at the centre, or the measurement of earth on the observer at the circumference.

(ii)

But from the other point of view the final definition can be seen as imposing a fresh orientation on the whole argument.

For if the final definition is taken in an extended sense, direction will no longer be correlated with movement towards or away from centre and circumference; as seen by an observer in either position, independently of the nature of the element to whose region he belongs. Direction will now be determined by the nature of the *element*, which will as it were override the definition simply in terms of an *observer*, stationed at the centre or at the circumference, in rather the way that the comparison between the *two* observers overrode the calculation of the *single* observer (the 'cosmic traveller').

From this point of view, we may wish to say that the comparison between the two observers, and what I called earlier the alignment of opposites, serves not merely to correlate the description of earth and fire as being measured each in its own place, but at the same time requires us, implicitly, to look at the situation from a more radically synoptic point of view than before, so that centre and circumference can now be seen as opposites precisely and only because the reader (or listener) no longer identifies himself exclusively with an observer in either position, and where furthermore the reader must not simply juxtapose the points of view of the observer at the centre and the observer at the circumference, but must adopt a new and independent formula which will rely, for the calculation of direction and weight, solely upon the movement of either element towards or away from its parent body.

Thus Plato's final definition, if it is taken in an extended sense, can be seen as imposing on the argument a new orientation, in a way not dissimilar to the way in which a new orientation is imposed on Plato's earlier analysis by the comparison of the two observers.

1. For the single observer, who walks around the central body, 'up' and 'down' are used in turn to describe the same part of the earth's surface.

2. In the comparison between the two observers, movement towards the earth's surface is invariably movement 'downwards', for the observer at the centre, while movement away from the earth's surface is alone reckoned as movement 'upwards'; and similarly for the observer stationed at the circumference.

3. If Plato's final definition is intended to include the calculation of fire at the centre and of earth at the circumference, then there will be a further shift in Plato's analysis of direction, and in effect a new opposition. The movement of either element will determine the meaning of 'up' and 'down', so that movement towards the centre, or towards the circumference, may be movement either 'up' or 'down', depending only on the nature of the element.

(iii)

This discrepancy between the earlier part of Plato's analysis and the final definition, if it is extended in the way I have indicated, does not in itself, it seems to me, indicate whether in fact Plato intends his analysis to be extended in this way, or not.

1. We may argue that the final definition is intended only as a summary of the analysis that has preceded, and that we should avoid therefore introducing into it any fresh conception.

2. On the other hand, we can argue that this second and final shift in Plato's analysis is simply the logical consequence of his earlier argument, and the explicitation of what had already preceded.

In favour of the *first* argument, we may perhaps say that: Plato has obviously intended simply to provide a generalising formula to cover both the cases that before had been described independently, and that this *and this alone* is the reason why he has chosen a form of words which avoids explicitly relating fire and earth to circumference and centre.

In favour of the *second* argument, we may perhaps say that: once we have appreciated the point that 'up' and 'down', in the way in which we have 'grown accustomed' to using those terms, are really dependent upon the movement of earth in relation to its parent element, and that this usage has no more value, and no less, than 'up' and 'down' as determined by the movement of fire, then we are obviously intended to conclude that the only true guide, the 'one thing which we must bear in mind' (cf. 63E3-4), is that the sense of up and down should be regulated by the movement of either element, *wherever it may appear*.

I do not myself find either argument conclusive. Both arguments, it seems to me, are true, with the exception of the phrases which I have italicised in each: but it is only the phrases which are italicised which would lead either argument to tell us whether or not Plato intends his theory to be taken in an extended sense.

(iv)

The same dilemma faces us, if we consider, more generally, the *counter-intuitive* character that must attach to the analysis of direction, once Plato's theory is extended in the way that I have argued would be required by the final definition.

According to the terms of the final definition, if we are to measure fire at the centre, then the observer on earth will have to allow that movement 'from head to foot', i.e. movement which he is accustomed to think of as movement *downwards*, is, for fire, movement *upwards*, and that movement from the ground to above his head, i.e. movement which he has been accustomed to thinking of as movement *upwards*, is, for fire, movement *downwards*.

It may be argued that Plato has given no warning of this radical shift in our conventional understanding of 'up' and 'down', and that so startling, and uncomfortable, a conclusion can hardly have been left implicit, or imposed upon the reader unawares.

On the other hand, from another point of view, it would not be unreasonable to take the counter-intuitive element in the extension to

Plato's argument as a consideration *in favour of* supposing that Plato may have deliberately intended this extension to his argument.

For in the earlier parts of his analysis Plato has already sought to play off our 'intuitions', one against the other, so to speak. Thus in the image of the man who walks around the surface of the central body the 'intuition' whereby one point on the earth's surface is 'up' and the other 'down' clashes with the intuition whereby the same two points are 'down' and 'up' respectively, when the observer is on the opposite side of the earth's surface. Our natural, or intuitive, measurements are, so to speak, designed solely, or at least primarily, for vertical description. Hence (in Plato's argument) the contradiction when they are applied to the description of a sphere. And hence the emphasis, in the conclusion to the first part of Plato's analysis, that the whole, *since it is spherical*, cannot properly be divided into 'up' or 'down' (63A4-6). The emphasis on sphericity is Plato's justification for rejecting the naïve assumption, outlined at the beginning of his analysis, where we do suppose that there are 'two opposite places, "up" and "down", which divide the whole between them' (cf. 62C3-8). The implication of Plato's argument is that our naïve assumption leads to contradictory 'intuitions' in the description of a spherical universe.

Now in this instance Plato does attempt to re-align our conventional assumption. As I have shown, the introduction of a second observer (63A6ff.), accommodates our *vertical* description to a *radial* description, in so far as the earlier opposition between 'up' and 'down', as applied in turn to different parts of the earth's surface, is absorbed into a new opposition whereby the observer at the centre is led to treat movement towards the earth as movement downwards, and only movement away from the centre as movement upwards.

The crux therefore is to know whether this resolution of conflicting 'intuitions' is meant to be repeated in the later part of Plato's analysis. For the resolution of the earlier conflict is itself achieved only at the cost of a different contradiction, between the measurement of an observer at the centre and the measurement of an observer at the circumference.

Does Plato intend the reader to rest content, as it were, with this new contradiction, or are we intended to recover, from the final definition, so to speak a higher resolution, whereby the 'intuitions' of an observer in either place are subordinated to the movement of an element, in the way that I have outlined?

If we are meant to do this, then the progression from direction defined by the intuition of the *observer* to direction defined solely by the movement of the *element* itself, and the presence therefore, in the final definition, of a counter-intuitive character, would have been paralleled by the opposition

between what I have called *vertical* and *radial* description in the earlier part of the argument.

1. The man who walks around the earth will need to be persuaded, in the continuation of Plato's argument, that, differently from his earlier supposition, movement to any part of the earth's surface is movement downwards, and that only movement away from the circumference is movement upwards.

2. If the analysis is extended in the way that would be required by the final definition, then the new observer will need to be persuaded that even this formula is inadequate: movement away from the centre is movement 'upwards' only for earth; for fire even movement away from the centre is movement 'downwards'.

(v)

Essentially therefore the dilemma that we face here is the dilemma inherent in the interpretation of many of Plato's writings.

From even a casual study of Plato's writings it is clear that sometimes radical consequences are left implicit, or rather are left to be inferred from the structure of Plato's arguments: the difficulty lies in distinguishing those instances where Plato has deliberately cut his argument short, and has deliberately left the reader to work out for himself the consequence of the argument, and those cases where Plato himself, one suspects, has not fully foreseen the conclusions implicit in his reasoning.

In the present instance, therefore, paradoxical though it may seem, Plato's failure to make explicit the counter-intuitive element implied by his final definition may be interpreted in two quite different ways, *either* as excluding, by its suddenness and surprisingness, a new orientation of the argument, *or* as sufficiently prepared for, not so much by the content, as by the form, of the preceding argument.

§ 3. WEIGHT AND RESISTANCE

Faced with this dilemma, I suggest we take a fresh look at the notion of resistance.

(i)

To clarify the notion of resistance which is common to both Plato's examples, of fire and of earth, we need to expose the final, and perhaps the most radical, mis-assumption in the passage from Taylor's commentary which I quoted earlier.

Taylor writes that:

‘By what is “light” or “heavy” in a given region we mean what is easy, or hard, to dislodge.’

But for Taylor there are two kinds of ‘dislodgement’.

1. ‘Anything is hard to dislodge from its own proper region, and the more there is of it, the harder the task is.’

2. ‘Anything is easy to dislodge from an “alien” region in the direction of its own, and the more there is of it, the less effort is required for its expulsion.’³

Only the *first* of these notions appears in Plato. The *second* kind of displacement is applicable only to the measurement of fire at the centre or of earth at the circumference, and is *not* introduced by Plato in any explicit form.

Taylor’s use of the same term, ‘dislodgement’, to cover both measurements, discourages the reader, as one suspects it has prevented the author, from considering whether the idea of ‘dislodgement’ or ‘expulsion’ of fire and earth from centre and circumference respectively is the only analogue to the notion of force (βία and βιάζω or βιάω, in passive and middle mood), which is the dominant concept in Plato’s account of weighing fire at the circumference and earth at the centre.⁴

In fact, if we start only from the circumstance which Plato has described, then there are, I suggest, two distinct analogues which would be equally possible for the measurement of an element which, as it were, starts off from a region other than its own.

1. We can imagine ourselves as *releasing*, or *letting go of*, a body of earth at the circumference, or as somehow *uncovering* and *letting loose* a quantity of fire from the centre.

2. Alternatively, I suggest, we can visualise ourselves as *holding back*, or as *seeking to prevent*, earth moving towards the centre, if we imagine ourselves as placed at the circumference, or as *seeking to prevent* fire moving towards the circumference, if we imagine ourselves at the centre.

(ii)

The *first* analogue is evidently that adopted by Taylor, and it is surely significant that once again Taylor’s assumption coincides with Aristotle’s conception. For Aristotle, earth does not fall and fire does not rise if either is ‘blocked’ (ἐμποδιζέσθαι) or simply ‘prevented’ (κωλύεσθαι). We

³ The three quotations are taken from *Commentary* 440.

⁴ ‘Force’: βία, 63C4, C8; βιάζω or βιάω, 63B6, C1, D2, D3.

must 'lift off' (ἀφαιρεῖν) the impediment, in the case of fire, or 'pull away' the blockage 'from underneath' (ὑποσπᾶν), in the case of earth.⁵

It is however the *second* analogue, it seems to me, which in fact follows more directly from Plato's two preceding images. All that Plato actually describes is the weight of fire, at the circumference, and of earth, at the centre, as being measured by the resistance which we experience in seeking to force, or drag, either element away from its parent body. The more immediate analogue to this, it seems to me, is not the idea of releasing fire from the centre, or earth from the circumference, but the idea of the resistance which we would experience in seeking to prevent either element, once it had been, or was about to be released, from moving back to join its parent body.

The difference between this, and Aristotle's conception, is not accidental. Aristotle's theory turns solely on the nature of the element: the direction in which it travels, the place which it occupies, the speed with which it moves. Superficially, Plato's theory is very similar. For Plato, weight is also dependent upon the direction in which a body travels, and, in a sense, on the place which it occupies. But for Plato the calculation of heavy and light between different quantities of the same element turns on a psychological factor: the degree of resistance which we experience, in seeking to remove a portion of an element from its native body.

This psychological factor has no place in Aristotle's theory, and understandably therefore it forms no part of the notion which he habitually employs of 'releasing' an element, by removing an obstacle from its path.

For the only 'human' element in Aristotle's expression of his theory arises if we suppose the agent which removes the blockage, or the impediment, to be an animate, and a human, agent. But even then how he does so—the degree of force which he may have to expend—is entirely incidental to the theory, and is nowhere mentioned by Aristotle.

(iii)

Indeed, even in Plato's theory such a conception would not be without its difficulty in the circumstance which Taylor describes. For if in fact we imagine ourselves at the circumference trying to dislodge one or other of Taylor's stones, it is, I think, a moot point whether in fact we should experience greater or less difficulty in moving the smaller or the larger stone. Certainly, on earth, it would be highly artificial to claim that in somehow releasing a larger quantity of fire we necessarily experienced less expenditure of effort than in releasing a smaller quantity.

⁵ This terminology is taken from *Phys.* viii 4, 255a30-256a3, *De caelo* iv 3, 311a6-12.

We might possibly think to argue that a larger force would be needed to keep down a larger quantity of fire, for example, and would therefore require less expenditure of energy for its removal. But not only is this to enter into speculative, and rather artificial, considerations; the very notion of 'keeping down' takes us back to the alternative notion of release to that in Aristotle, and so to the idea that a *greater* force is needed to restrain the *larger* quantity—precisely the correlation opposed to the assumption that Taylor has made.

It is difficult, in fact, to avoid the suspicion that Taylor's assumption is in part the result of extrapolating psychologically the effect of momentum. A large stone will fall with greater momentum than a smaller one. We may come to think, therefore, that it would have been easier for us to start the larger stone on its journey.

But in fact if we do introduce the notion of momentum, we are again but half a step from imagining ourselves as experiencing, not the force with which initially we release a body, but the force which we would subsequently have to exert, or conversely the force which subsequently we would experience, in seeking to keep the body from falling or rising. And once we take that step, then the conclusion is again not that the *larger* body is *easier* to release, but that the *larger* body is *more difficult* to retain—the opposite correlation therefore to that which Taylor requires.

The *second* analogue therefore provides by far the more natural analogue, it seems to me, to the examples which Plato has actually described of weighing fire at the circumference, and earth at the centre. The point will be that in either case, whether measuring fire at the circumference or centre, earth at centre or circumference, we experience the resistance which fire or earth will exert against our attempt to remove either element from its parent body, *or* to prevent it from returning thither.

From this it will follow that if we measure earth at the circumference, or fire at the centre, then the larger body is heavier, no less than if we measure earth at the centre or fire at the circumference, because in either case we measure the resistance exerted by earth or by fire in returning to its native body.

1. The larger body will be heavier, because we shall experience more resistance with a larger body both when we seek to drag it away from its parent body, and when we seek to prevent it returning thither.

2. Equally, the smaller quantity is lighter, in the sense that we can the more easily detach it from its parent body, and with less force prevent it returning thither.

(iv)

In taking Plato's conception this far, we see the final difficulty in the way of determining whether or not Plato in fact intends us to extend his theory.

For the two factors in the calculation of resistance, the resistance which we experience in seeking to drag a body away from its native element, and the resistance which we experience in seeking to prevent it returning thither, are in fact both present in the simple calculation of the weight of fire at the circumference and of earth at the centre.

1. Plato talks of the force with which we drag earth or fire into the 'alien' air (ἔλκειν, βιάζεσθαι, ῥώμη); and of the greater or less ease with which a larger or smaller portion of either element 'follows' (συνέπεσθαι).⁶

2. But once either body is held aloft (cf. μετεωριζόμενοι, 63C2), we could as well regard ourselves as calculating the force needed to prevent either body returning to its like.

If therefore we imagine ourselves at the centre, calculating the resistance needed to prevent fire from 'rising', or at the circumference, calculating the resistance needed to prevent earth from 'falling', then in either case we are in effect simply isolating a factor already present in the circumstance which Plato describes for calculating the weight of fire at the circumference and of earth at the centre.

Precisely because this interpretation makes the measurement of fire at the centre and of earth at the circumference so natural an extension of the two circumstances which Plato actually describes, the measurement of fire at the circumference and of earth at the centre, it becomes the more difficult to decide whether or not Plato in fact intended this extension to his theory.

For the need, on Taylor's interpretation, to invert the consequences of measuring fire at the circumference and earth at the centre, in such a way that the larger quantity in either case becomes lighter instead of heavier, not only is difficult to reconcile with Plato's final definition; it is the more implausible precisely because it is an inversion of the conclusion which Plato in fact describes earlier in his analysis.

The alternative interpretation, because it simply extends the principles which Plato does establish, without introducing a new and paradoxical circumstance, could either have been the more easily taken for granted, or the more easily left out of account.

⁶ "ἔλκειν, 63B6, C7-8: βιάζεσθαι and βία, 63B6, C1, C4, C8, D2, D3: ῥώμη, 63C1; συνέπεσθαι, 63C3, D2.

(v)

I conclude that it is impossible to calculate precisely with what degree of conscious intent Plato may have planned his theory to include both (1) the measurement of fire at the circumference and of earth at the centre and (2) the measurement of fire at the centre and of earth at the circumference.

Throughout his analysis, Plato writes explicitly only of the measurement of earth at the centre and of fire at the circumference. But there is perhaps some ambiguity in the final definition. The final definition is most easily taken as describing the use of a pair of scales, and from that point of view is most simply read as no more than a summary of the passage that has preceded. On the other hand, the final definition is introduced as providing a complete account of 'heavy' and 'light' and of 'up' and 'down', and so at least by implication, one might think, should include the measurement of fire at the centre and of earth at the circumference.

Very possibly the nature of the choice prevented Plato seeing it. The conception of weight as defined by resistance, in the way that I have described, precisely because it is common to both circumstances, very possibly concealed from Plato the need to formulate his theory any more explicitly than he has done.⁷

⁷ To the reader who finds the argument of this chapter impossibly plodding, and the conclusion tame, I would point out only that an accurate and (if such things are possible) definitive interpretation of Plato's intention at this point will prove to be indispensable both in order to arrive at an eventual conciliation of the 'two' theories of weight in the *Timaeus* (see esp. pp. 155-6 below) and in order to unravel the criticisms which Theophrastus makes of Plato's theory (see below ch. XIV § 1, esp. pp. 273-4, and cf. ch. XV § 5, pp. 304-11 below).

I have had to keep to a rather mechanical interpretation of Plato's intention at this point, in order to avoid encroaching on my later analysis, where I argue that the main purpose of Plato's present definition is to introduce a sensible percipient, and to describe 'heavy' and 'light' in a way that will make either character especially apparent to the faculty of sense (see esp. ch. VIII § 3, pp. 153-7 below). From this point of view, Plato's need is not so much to account for the measurement of earth at the circumference, as to account for the measurement of fire (or of substances made of fire) at the centre, since it is of course at the 'centre' that we experience 'heavy' and 'light' as sensible attributes. On this point, see further pp. 369-79 below.

PART TWO

WEIGHT AND NUMBER

CHAPTER FIVE

ELEMENTAL TRIANGLES

§ 1. THE NUMBER OF TRIANGLES

The preceding chapters contain the essentials of Plato's theory of weight as measured by direction and by resistance. Initially, I introduced this theory as Plato's longer and more detailed account of weight. For earlier in the *Timaeus* Plato introduces an identifiable theory of weight, which is yet distinct from his later analysis. This is a theory of weight as defined by the number of elemental particles.

At first sight, this theory is alluded to, it seems, almost in passing, and accordingly it has been largely neglected by modern scholars. Cherniss, for example, speaks of this earlier theory as a 'passing remark', even a 'chance remark', the 'implications' of which 'are definitely rejected' in Plato's later analysis'.¹ Solmsen notes with approval the 'illuminating analysis' in Cherniss, and tells us that the earlier theory is not 'a clue to Plato's final conception of weight or lightness'.²

This seems to me wholly wrong. The earlier theory, I shall argue, is doubly important. The earlier text is essential to an understanding of Aristotle's criticism of Plato, for Aristotle pins his criticism on the earlier and not the later theory. Within the structure of the *Timaeus* as a whole, the earlier theory, of weight as defined by number, is intended by Plato as an essential correlative to the later theory, of weight as defined by direction and by resistance.³

However, before turning to these two broader points, it is necessary to establish more precisely the content, and the extent, of the earlier theory. In particular, in this chapter, I consider an apparent anomaly in Plato's theory of triangles as the elemental particles: namely whether the elemental triangles are all ultimately of the same size or whether they differ in size. For upon the resolution of this apparent anomaly there depends the

¹ Harold F. Cherniss, *Aristotle's criticism of Plato and the Academy* (henceforth *ACPl*) (Baltimore, 1944) 136-9, cf. 161-5.

² Friedrich R. H. Solmsen, *Aristotle's system of the physical world, a comparison with his predecessors* (New York, 1960) 280 n. 19.

³ I shall argue therefore, in part three of my essay, that Aristotle is to be taken seriously in the criticisms he makes of Plato's theory: see esp. pp. 175-82 below. By contrast, on Cherniss' interpretation, Aristotle ends up merely tilting at a windmill. For example, Paul Moraux, in the introduction to his Budé edition of the *De caelo* (Paris, 1965), echoes exactly Cherniss' judgement, p. cxlvi: 'Si l'on cherche, dans le *Timée*, la théorie qu'Aristote critique en long et en large, on ne l'y trouve que dans une remarque incidente et accessoire.'

more precise formulation of the definition of weight in terms of the number of elemental particles.

(i)

In this earlier passage (53Cff.), Plato's purpose has been to construct the five primary regular solids, from which are formed, or to which in some way there correspond, the four Empedoclean elements and the spherical shape of the cosmos.⁴

Three primary solids, the tetrahedron, the octahedron and the icosahedron, correspond respectively to fire, air and water. Each face of each of these three solids is constituted by an equilateral triangle, which in turn is formed from a number of right-angled scalene triangles, of a '60°-30°' type, i.e. each is of a kind to form one half of an equilateral triangle.

These three elements are mutually transformable by being resolved into their component triangles. Earth falls outside the cycle of change, in being composed of cubes, each of whose faces is resolvable into half-squares, i.e. into right-angled isosceles triangles. A fifth primary solid, the dodecahedron, also falls outside the cycle of change, in that its faces are made of pentagons. This figure is taken to represent the cosmos as a whole.

It is in describing the correspondence between each of the three primary solids whose faces are formed by equilateral triangles with the three elements, fire, air and water, that Plato introduces the correlation of weight with number.⁵

⁴ The whole passage runs from *Tim.* 53C4-58C4.

⁵ Useful diagrams to illustrate Plato's theory are attached to Paul Friedländer's article, 'Structure and destruction of the atom according to Plato's *Timaeus*', *University of California publications in philosophy* vol. 16 n° 11 (1949) 225-48, reproduced in *Platon* Band i, 2nd edn (Berlin, 1954), and in Gregory Vlastos, *Plato's universe* (Oxford, 1975) 74-8. Useful facts and figures concerning the structure and behaviour of the solids may also be found in an article by E. M. Bruins, 'La chimie du *Timée*', *RMM* 56 (1951) 269-82. See also Sir Thomas Heath, *A history of Greek mathematics* i (Oxford, 1921) 158-62, 294-7.

It is customary to remark that in using the dodecahedron to represent the cosmos as a whole, Plato means to exploit the fact that of the five regular solids the volume of the dodecahedron approximates most nearly to the volume of the sphere in which it can be inscribed. (The reason for this at first sight rather disconcerting fact is that, although the dodecahedron and the icosahedron have the same number of sides or edges, the dodecahedron, in being made from pentagons, has the larger number of vertices, and so approximates more nearly to the shape of a sphere.) On the other hand, this fact, even supposing Plato knew of it, may simply have been a happy coincidence, rather than a determining factor in Plato's choice of function for the solids. Other more abstruse reasons for identifying the dodecahedron with the cosmos were rife in antiquity, and are usefully listed by Daniel Wytttenbach, in his note on *Phaedo* 110B, where Plato compares the earth (not the cosmos) to balls sewn together from twelve pieces of skin, see *Platonis 'Phaedon'* (Lugduni Batavorum, 1810) 304-7.

(ii)

Fire, Plato tells us, must be given the ‘most mobile’, the ‘smallest’ and the ‘sharpest’ body, 56A2-6: εὐκίνητότατον ... σμικρότατον ... ὀξύτατον.

The body with the fewest surfaces will be the ‘most mobile’ and the ‘sharpest’, 56A6-B1: τὸ μὲν (sc. εἶδος) ἔχον ὀλιγίστας βάσεις εὐκίνητότατον ἀνάγκη πεφυκέναι, τμητικώτατόν τε καὶ ὀξύτατον ὃν πάντη πάντων ...

It will also be the ‘lightest’ body, because it is made from ‘the smallest number of like parts’, 56B1-2: ... ἔτι τε ἐλαφρότατον, ἐξ ὀλιγίστων συνεστὸς τῶν αὐτῶν μερῶν.

This body is the tetrahedron, which is therefore associated, or identified, with fire, 56B3-5: ἔστω δὴ κατὰ τὸν ὀρθὸν λόγον καὶ κατὰ τὸν εἰκότα τὸ μὲν τῆς πυραμίδος στερεὸν γεγονὸς εἶδος πυρὸς στοιχεῖον καὶ σπέρμα.

In this rapid sequence of associations, one substitution is obvious: the replacement of size (‘smallest’, 56A3-4) by weight (‘lightest’, 56B1). So too is the reason for it: the tetrahedron is the ‘lightest’ because it is also the ‘smallest’ of the three transformable polyhedra.

This is clear from the definition of the body which is ‘lightest’ as being so because it is made ‘from the smallest number of like parts’ (56B1-2). The explanation is the same as for mobility: the body which is ‘most mobile’ has ‘the fewest faces’ (56A6-7). In these two definitions, the ‘surfaces’ or ‘faces’ (βάσεις, 56A7) will be the equilateral triangular faces common to the tetrahedron, to the octahedron and to the icosahedron. The ‘parts’ (μερῶν, 56B2) could be these same faces, but are perhaps more probably the half-equilaterals from which these faces have been constituted, in Plato’s construction of the regular solids (54D3ff.). For polyhedra whose triangular faces are the same in size, the comparison of ‘parts’ and of ‘faces’ will yield the same result. The tetrahedron is the smallest body, both because it has ‘the fewest faces’, and because it therefore has ‘the least number of like parts’, of the three transformable polyhedra.⁶

The requirement that, for weight, we compare ‘the same parts’ or ‘like parts’ (cf. τῶν αὐτῶν μερῶν, 56B2) will not be without its complications in the continuation of Plato’s argument. But for the moment the meaning is plain. The tetrahedron will be the ‘smallest’ and the ‘lightest’ body, pro-

⁶ The point of my restriction is that a tetrahedron of any size will of course always have the ‘fewest’ faces in relation to an octahedron and an icosahedron. But with the difference I have suggested between ‘faces’ and ‘parts’ the tetrahedron will have the ‘fewest like parts’ only if the triangular faces are the same (or not too disproportionate) in size between the different polyhedra being compared. Since there has so far in Plato’s argument been no indication of polyhedra whose faces are not all the same size, this is therefore, in the present context, a distinction without a difference; as I remark in my next paragraph, the difference will be crucial later.

vided that the triangular faces of the three transformable polyhedra are the same in size as in kind. This will be so, if the faces of the three polyhedra are made up from the same number of equal half-equilateral triangles, as had fairly obviously been Plato's intention in the construction of the geometrical solids.⁷

(iii)

In the elliptical, and indeed enigmatic, manner characteristic of his writing in the *Timaeus*, Plato adds, after his definition of fire as 'lightest' (56B1-2), that 'the second body will have these same properties in a second degree, and the third body will have these same properties in a third degree', 56B2-3: τὸ δὲ δεύτερον (*sc.* εἶδος) δευτέρως τὰ αὐτὰ ταῦτ' ἔχειν, τρίτως δὲ τὸ τρίτον.

The second and third bodies, we learn, are air and water respectively (56B5-6). Plato had already told us that water was the 'least mobile' and the 'largest' of the three transformable elements, and that in both respects air was 'in the middle' in relation to water and to fire (56A2-5). Plato's present formula should mean therefore that air is heavier than fire, and that water is the heaviest of the three transformable elements.

The heaviness both of air and of water does in fact crop up in the course of Plato's enumeration of the sensible substances formed from the elements.

Air, we are told, 'presses upon' earth at one stage in the process of earth becoming stone, 'in so far as air is heavy', 60C2-5: ὁ δὲ (*sc.* ἀήρ) ἄτε ὦν βαρύς, ὡσθεις καὶ περιχυθεὶς τῷ τῆς γῆς ὄγκῳ, σφόδρα ἔθλιψεν συνέωσέν τε αὐτὸν εἰς τὰς ἑδρας ὅθεν ἀνῆι ὁ νέος ἀήρ. A passage in Aristotle's *Physics*, rightly understood, shows that in the fifth century it had been necessary to combat the confusion of air and empty space.⁸ That was perhaps no

⁷ The construction of the geometrical solids, see 54D3-C6. The 'complications' are introduced almost immediately below, pp. 83ff. In the definition of fire as 'lightest' (ἐλαφρότατον, 56B1), the ambiguity of the adjective as between lightness and speed is often remarked upon, for example by Cherniss, *ACPl* 139 n. 85, *cf.* Solmsen, *Aristotle's system* 280 n. 19. The essential point to appreciate, it seems to me, is that this ambiguity reflects the general fifth-century association of fast and light, and of heavy and slow, which is noted by Plutarch, and which I have commented on in my earlier essay, vol. i pp. 315-29. In this instance it is, I think, justifiable to translate ἐλαφρότατον as 'lightest', both because the word is here used to describe a character of the tetrahedra *in addition to* their mobility (εὐκίνητότατον ... ἔτι τε ἐλαφρότατον, 56A7-B1), and because ἐλαφρόν is opposed to βαρύ and is paired with χούφον in the account of weight as defined by resistance (63C5 and D7, quoted above pp. 29 and 35). These two points seem to me sufficient to refute Archer-Hind's assertion, edn 201, that ἐλαφρότατον here means only 'nimble, mobile', and not 'light'.

⁸ *Phys.* iv 6, 213a12-b2; *cf.* iv 4, 212a12. This passage has often been misunderstood, for example by William K. C. Guthrie, *A history of Greek philosophy* (henceforward *History*) ii (Cambridge, 1965) 224-5. But this is a point which I hope to pursue elsewhere.

longer a live issue when Plato was writing. But the fact that air should be heavy is still sufficiently paradoxical for Aristotle, no less than for Plato, to need to stress the point.⁹

More specifically relevant to the theory of weight as defined by number is Plato's account of water. There are two kinds of water, a fluid and a less fluid kind: respectively 'liquid' water and 'fusible' water. The less fluid of the two kinds, 'fusible' water, is made of 'larger' elements. As well as being the less mobile it is also 'heavy', 58D8-E2: τὸ δὲ (sc. χυτὸν γένος τοῦ ὕδατος) ἐκ μεγάλων καὶ ὁμαλῶν (sc. γεγονόσιν μερῶν) στασιμώτερον μὲν ἐκείνου καὶ βαρὺ πεπηγὸς ὑπὸ ὁμαλότητός ἐστιν.¹⁰

§ 2. THE SIZE OF TRIANGLES

At the same time, the two kinds of water highlight a difficulty in Plato's scheme. For water is not simply heavier in being made from icosahedra, each of which has a larger number of triangles than the tetrahedra from which fire is made. The two kinds of water are made from particles which have a different size, 58D4-E2: τὰ δὲ ὕδατος (sc. γένη) διχῇ μὲν πρῶτον, τὸ μὲν ὑγρόν, τὸ δὲ χυτὸν γένος αὐτοῦ. τὸ μὲν οὖν ὑγρόν διὰ τὸ μετέχον εἶναι τῶν γενῶν τῶν ὕδατος ὅσα σμικρά, ἀνίσων ὄντων ... τὸ δὲ (sc. χυτὸν γένος) ἐκ μεγάλων καὶ ὁμαλῶν ...

This is a consequence of Plato's theory that variations in kind within each of the four elements are to be explained by variations in size of the triangles out of which they are composed. I paraphrase, 57C7-D3:

'By ways and for reasons such as these there arose the <appropriate> number of primal and simple <cosmic> bodies <i.e. the four traditional 'elements', earth, air, fire and water>.

'However, the fact that within each kind of body there are implanted a number of different types <of each kind> is to be explained and derived from the way in which each of the two <original> elements <namely the two kinds of triangle, the half-square and the half-equilateral,> was put together in the first place.

'Each of the two original constructions yielded the triangle <which it did>, not in one size only, but <in a number of different sizes, so that

⁹ I take this to be the implication of Aristotle's remark, in the *De caelo*, that 'each of the elements, except fire, has heaviness in its own place, even air' (καὶ ὁ ἀήρ, iv 4, 311b9).

¹⁰ To make my quotations from the Greek intelligible, I perhaps too freely add a noun where Plato contents himself with the article or adjective, and where the context often allows the choice of more than one term: for example at 58E1 we could perhaps as well understand γενῶν (cf. 58D6) as μερῶν (cf. 59B6), while at 56A6 and B2, quoted a few paragraphs above, we could as well understand εἶδος (cf. 56A2) as σώμα (cf. 56A4). I also paraphrase these terms freely as 'body', 'parts', 'elements' and 'elemental particles'. Any attempt to echo Plato's vocabulary consistently would not only be cumbersome, but would also give a false impression of the degree to which Plato has evolved, and relies upon, a technical vocabulary.

there were > larger and smaller triangles < of each kind > , as many as were needed for the types of things that there are found to be among the < four > kinds < of simple bodies > .'

This at once complicates any simple correlation of weight with number, for if the triangles vary in size, are we to say simply that the element with the fewest number of elementary triangles is the lightest, or must we add that the lighter element should also be made of the smaller, or smallest, size of triangle?

(i)

Fortunately, this dilemma is eased by a perceptive and ingenious analysis of this passage, and of Plato's whole account of the construction of the primary regular solids which correspond to the elements and to the cosmos, by Professor Cornford.¹¹

Cornford argues that the triangles which differ in size are not the elemental triangles, for if they were, then transmutation would be possible only between kinds of fire or air or water that were made of triangles of the same size, and not, as Plato clearly seems to intend, between any and every kind of fire, air and water. Cornford therefore suggests that the triangles which differ in size are themselves made up from triangles which are equal in size.

This then explains why Plato should have chosen to use more elemental triangles than strictly he would have needed in order to build up the equilateral triangles which form the faces of the three regular bodies which correspond to fire, air and water, and of the square faces of the cubes which are identified with earth.

1. Two right-angled scalene triangles of the right kind would make up an equilateral triangle: Plato uses six.¹²

2. Two right-angled isosceles triangles would make up a square: Plato uses four.¹³

To adapt the explanation which Cornford proposes: Plato has deliberately chosen a method of division which can be used to generate different grades of polyhedra from a larger or smaller number of triangles (half-squares or half-equilaterals) which will all ultimately be equal in size as well as the same in kind (for either kind of triangle).¹⁴

¹¹ *Cosmology*, esp. pp. 230-9.

¹² *Tim.* 54D7-E3.

¹³ *Tim.* 55B3-7.

¹⁴ The equilateral faces which will be used for the construction of the three transformable polyhedra are built up from six half-equilaterals by a method which is equivalent to bisecting the angles of the whole equilateral (*cf.* 54D7-E3). This corresponds to the divi-

In this way Plato has the double advantage: that different sizes of regular bodies can be used to explain different varieties of the four elements, while any variety of each element is still transformable into any variety of another element, because each of the triangles from which the regular bodies are composed, no matter what the size of the triangles, can be resolved into a larger or smaller number of elemental triangles, which are all of the same kind and size: with a barrier set only between earth on the one hand, and water, air and fire on the other.

(ii)

I have repeated (adapting slightly) what seem to me Professor Cornford's most important arguments. Cornford does not himself note a final, and peculiarly persuasive, argument for his theory: namely that this conclusion seems to have been shared by Aristotle.

In the third book of the *De caelo* Aristotle repeats the earlier theory of the *Timaeus*. Bodies are heavier depending on the number of surfaces, cap. 1, 299b31-300a1: εἰ μὲν πλῆθει βαρύτερα τὰ σώματα τῶν ἐπιπέδων, ὥσπερ ἐν τῷ Τιμαίῳ διώρισταί ... However, when Aristotle returns to this theory in book four, he notes specifically that for Plato a body is heavier if it is made up of a greater number of *equal* parts, cap. 2, 308b3-12: ... ἐν ὑπεροχῇ γὰρ τῶν ἴσων μορίων βαρύτερον ἕκαστόν ἐστιν ... ἔκ τινων γὰρ τῶν αὐτῶν εἶναι πάντα τὰ σώματα καὶ μιᾶς ὕλης, ἀλλ' οὐ δοκεῖν.

These 'parts' are specified as triangles in the criticism which follows almost immediately, 308b15-16: ὥστ' οὐ δι' ὀλιγόττητα τῶν τριγώνων, ἐξ ὧν συνεστάναι φασὶν ἕκαστον αὐτῶν, τὸ πῦρ ἄνω φέρεσθαι πέφυκεν.

The fact that there are *equal* parts is then repeated in the course of the comparison that Aristotle makes between Plato's theory and that of Democritus. A body may be larger than another and lighter, or smaller and heavier. This discrepancy of weight and volume makes it 'inadequate' for Plato, or the Platonists, to claim, as they do, that bodies which weigh the same are made from *equal* primary parts, for in that case bodies which weigh the same would have to be the same in volume. Aristotle writes, 308b33-5: δῆλον οὖν ὡς οὐχ ἱκανὸν τὸ φάσκειν ἐξ ἴσων συγκεῖσθαι τῶν πρώτων τὰ ἰσοβαρῆ· ἴσα γὰρ ἂν ᾦν τὸν ὄγκον.¹⁵

sion of a half-equilateral into three smaller half-equilaterals, each of which can then be further subdivided, by the same process, and so on *ad infinitum*. So too with the cubes. The half-squares which make up the cube have already been once bisected, so that the square faces of the cube are made up from four half-squares (*cf.* 55B3-C4); these half-squares can themselves be endlessly bisected into smaller half-squares. Both methods of division can therefore be used to construct polyhedra in as many different sizes as are required, from half-equilaterals and from half-squares which (if the process of division is stopped at an appropriate point) will be ultimately equal in size as well as the same in kind, for each of the two types of triangle.

¹⁵ For the context of this passage, see vol. i pp. 80ff.

The only passage in the *Timaeus* which corresponds directly to this formulation of Plato's theory is the passage that I have just examined (53Cff.). Aristotle's assertion that fire is lightest 'because of the fewness of its triangles' (*De caelo* iv 2, 308b15-16) clearly picks up Plato's point that fire is lightest 'because it is made up of the fewest like parts' (*Tim.* 56B1-2). The assertion that weight depends on the number of 'surfaces' (*De caelo* iii 1, 299b31-300a1) is Aristotle's generalisation of this statement.

If therefore Aristotle means to paraphrase this part of the *Timaeus*, as it seems he must do, then the fact that Aristotle should paraphrase what Plato calls 'the same parts' (τῶν αὐτῶν μερῶν, 56B1-2) both as 'the same things' or 'parts' (τινῶν ... τῶν αὐτῶν, *De caelo* iv 2, 308b10-11) and as 'equal parts' (τῶν ἴσων μορίων or ἴσων ... τῶν πρώτων, iv 2, 308b9, b34) will mean, it seems to me, that he shares the conclusion of Cornford's analysis. For although Plato has himself cast his initial definition of fire as 'lightest' in terms of a comparison of 'the same' or 'like' parts (*cf.* 56B1-2), that definition will no longer necessarily be true, as a general statement of Plato's theory, once we have been introduced to triangles that differ in size (57C7ff.). Once we have been introduced to triangles that differ in size, then it will of course be true that the triangles continue to be 'the same' in kind for each of the two types of polyhedra: they will continue to be half-squares or half-equilaterals. But 'the like' parts will no longer be 'equal' parts unless we *either* suppose that the comparison of weight is now limited to polyhedra made from triangles all of the same grade, *or* adopt Cornford's thesis, where even different grades of polyhedra are made ultimately from triangles (half-squares or half-equilaterals) equal in size as well as the same in kind.

(iii)

It is true that Aristotle may have intended to adopt the restriction on the theory, whereby we compare polyhedra all of the same grade. It is true again that Aristotle may simply have neglected Plato's later announcement of the differences in size attaching to the triangles from which the solids are formed. But this is not at all the impression given when, in the first passage I quoted from book four of the *De caelo* (iv 2, 308b3-12), Aristotle clearly specifies that the formulation he has given of Plato's theory will explain differences of weight between 'every quantity of like kind', for example between different quantities of lead or between different quantities of copper, as well as differences of weight between different types of body, for example between wood and lead.¹⁶

¹⁶ This distinction has been confused in Stocks' translation of the passage: see pp. 353-5 below.

For Aristotle, as presumably for Plato, this allows for a direct comparison of weight, as defined by the number of triangles, between any and every variety of sensible substance: with the difference only that at this point Aristotle chooses to ignore Plato's distinction between earth and the three transformable elements.¹⁷

A direct comparison of weight between different substances would seem to require, and therefore to imply, that the ultimate constituents of the substances compared, the elemental triangles, are the same in size as in kind.

Thus Aristotle's evidence would seem to provide reassurance on precisely the point where reassurance is needed, if we are to be able to adopt Cornford's reconstruction with confidence: the different elements—with the exception only of earth—and the different varieties or combinations of each element are mutually transformable, or at least their weight is directly comparable, in virtue precisely of the number of equal elements or triangles from which they are constituted.¹⁸

(iv)

I conclude therefore that in the passages which I have quoted (56A6-B5, 58D8-E2), preceding the more detailed analysis of heavy and light in terms of up and down, Plato's intention is to offer a straightforward correlation of heavy and light with a larger and smaller number of elemental triangles.

This is not contradicted by Plato's introduction later of different sizes of the two original triangles (half-squares and half-equilaterals) for the different varieties of each element; for Plato's intention, seemingly recognised by Aristotle, would appear to be that while the faces of the regular solids will therefore be larger or smaller, to account for variations within each kind of element, nonetheless every size of equilateral triangle, and every size of square, is composed ultimately of a larger or smaller number of the appropriate kind of right-angled triangles, each of which is equal in size as well as the same in kind.

In that case, differences of size are reducible to differences of number. 'Fusible' water will be made from a larger number, and 'liquid' water will be made from a smaller number, of triangles which are ultimately equal in size as well as the same in kind.¹⁹

¹⁷ Plato's exclusion of earth from the transformation of elements is criticised extensively in book three of the *De caelo*, cap. 7, 306a1-20.

¹⁸ The place of the passages I have quoted from the *De caelo* will be discussed in my later chapters (ch. IX and X). For the passage from book three, see esp. pp. 193ff. below. For the passages from book four, see esp. pp. 176ff. and 199ff. below.

¹⁹ I consider separately a number of objections that have been made to Cornford's thesis, as well as further objections to the use that I have made of Aristotle's evidence; see

§ 3. WEIGHT AND DENSITY

Weight defined by number is, however, not the only conception of weight introduced by Plato into his account of the traditional cosmic elements or *gene*.²⁰

Immediately after announcing that there are different sizes of triangle (57C7-D6), and before illustrating in detail the many varieties of substance that can be explained thereby (58C5ff.), Plato adds a brief account of movement and rest within the cosmos (57D7ff.).

Movement is, in general, the result of a lack of uniformity (57E1-58A2): Plato here picks up the Presocratic motif that I have already noted in my first essay.²¹ The lack of uniformity is maintained by the constant interpenetration and interchange of the elements (58A2-4). This activity is stimulated by 'the revolution of the whole' which, 'endowed by nature with an urge to close in upon itself', exerts pressure upon the things contained within it and thereby 'forbids any empty space to be left' within the cosmos, 58A4-7: ἡ τοῦ παντός περίοδος ... πρὸς αὐτὴν πεφυκυῖα βούλεσθαι συνιέναι, σφίγγει πάντα καὶ κενὴν χώραν οὐδεμίαν ἐξλείπεσθαι.

This pressure from the revolution of the whole forces the elements in upon one another: fire is able to make its way in among the particles of each of the other elements, air can penetrate water and earth, καὶ τὰλλα ταύτῃ (58A7-B2). The reason is two-fold: that fire is the finest element, and that 'elements which are composed of the largest parts have the largest "emptiness" between them, while the smallest elements leave the

Note 4, pp. 341-58 below. Some difficulties which the reader may be aware of, even with the adoption of Cornford's thesis, are considered in § 4 of this chapter ('Problems', pp. 96ff. below).

When I come to reconsider Cornford's thesis I shall adopt for convenience the distinction between 'elemental' and 'subelemental' triangles. 'Subelemental' triangles will be the half-equilaterals and the half-squares which go to make up the 'elemental' equilateral triangles and the 'elemental' squares used directly for the faces of the regular solids. Thus Plato uses four 'subelemental' half-squares to construct each of the square faces of the cube (55B3-7) and six 'subelemental' half-equilaterals to construct each of the equilateral faces that will be used for the tetrahedron, octahedron and icosahedron (54D7-E3). Cornford's thesis, in the form in which I have restated it, is then that the two types of subelemental triangle, the half-squares and the half-equilaterals, used for the construction of the different grades of their respective polyhedra, will, for each type, be ultimately equal in size as well as the same in kind. Transformations will then be possible between any grade of earth, for all grades of cube will be made ultimately from a smallest subelemental half-square. Transformation will be possible between any grade of fire, air or water, because all grades of the three corresponding polyhedra will be made ultimately from a smallest subelemental half-equilateral.

²⁰ Plato is not consistent in his use of *genos* and *eidos*; for this use of *genos*, see 55E1, cf. 82A1-2.

²¹ Vol. i pp. 311-15; cf. *Empedocles' cosmic cycle* (henceforward *ECC*) (Cambridge, 1969) 38-45.

smallest ‘emptiness’’, 58B2-4: τὰ γὰρ (*sc.* γένη) ἐκ μεγίστων μερῶν γεγονότα μεγίστην κενότητα ἐν τῇ συστάσει παραλέλοιπεν, τὰ δὲ σμικρότατα ἐλαχίστην.

Thus the force of compaction drives the smallest particles into the ‘empty spaces’ between the larger figures, 58B4-5: ἡ δὲ τῆς πιλήσεως σύνοδος τὰ σμικρὰ εἰς τὰ τῶν μεγάλων διάκενα συνωθεῖ.

From this it follows that the smaller particles, driven in among the larger particles, cut them into pieces, while the larger particles squeeze together the smaller particles (58B6-7); and so it is, that by the constant interchange of the elements the source of unlikeness is preserved and movement in the cosmos continues endlessly (58B8-C4).

The details of this account have been disputed. However, the only point immediately relevant to my thesis is that Plato’s initial denial of ‘empty space’ (κενὴν χώραν οὐδεμίαν, 58A7) proves, in the course of the passage, not to exclude ‘emptiness’ (κενότητα, B3) or ‘gaps’ (διάκενα, B5), especially between the larger particles. For it is this feature which, in the pages that follow, Plato exploits to give an account of weight as defined by density.²²

(i)

Plato specifies three products of the less fluid or ‘fusible’ as distinct from the runnier or ‘liquid’ kind of water: gold, *adamas* (perhaps steel, possibly diamond) and copper.²³

Of gold and *adamas* Plato writes, 59A8-B5: τούτων δὲ πάντων ὅσα χυτὰ προσείπομεν ὕδατα, τὸ μὲν ἐκ λεπτοτάτων καὶ ὁμαλωτάτων πυκνότατον γιγνόμενον, μονοειδὲς γένος, στίλβοντι καὶ ξανθῷ χρώματι κοινωθέν, τιμαλφέστατον κτῆμα χρυσὸς ἡθημένος διὰ πέτρας ἐπάγη· χρυσοῦ δὲ ὄζος, διὰ πυκνότητα σκληρότατον ὃν καὶ μελανθέν, ἀδάμας ἐκλήθη.

Of copper he writes, 59B6-C3: τὸ δ’ ἐγγὺς μὲν χρυσοῦ τῶν μερῶν, εἶδη δὲ πλείονα ἐνὸς ἔχον, πυκνότητι δέ, τῇ μὲν χρυσοῦ πυκνότερον ὄν, καὶ γῆς μόριον ὀλίγον καὶ λεπτὸν μετασχόν, ὥστε σκληρότερον εἶναι, τῷ δὲ μεγάλα ἐντὸς

²² For the controversy surrounding this passage, especially the meaning of σφίγγει (58A7), and for Plato’s apparent inconsistency over the admission, or denial, of void, see Note 5, pp. 359-65 below.

²³ For the distinction between the two kinds of icosahedra, the ‘fusible’ kind (χυτόν), made of larger particles, and the ‘liquid’ kind (ύγρόν), made of smaller particles, see 58D4-E7, quoted in part pp. 83-4 above. The identification of *adamas* is uncertain. For the two possibilities mentioned here, diamond and steel, see Blümner, ‘Diamant’, Pauly-Wissowa, *RE* 5 (1905) 322-4; cf. Rommel, *ibid.* Reihe 2 Band 3 (1929) 2126-33. David E. Eichholz leaves the question open, *Theophrastus ‘De lapidibus’* (Oxford, 1965) 100-1. Robert Halleux, *Le problème des métaux dans la science antique* (Paris, 1974) 90-1, proposes an identification with haematite.

αὐτοῦ διαλείμματα ἔχειν κουφότερον, τῶν λαμπρῶν πηκτῶν τε ἐν γένος ὑδάτων χαλκὸς συσταθεὶς γέγονεν.²⁴

The constitution of the first two items in Plato's account is clear enough.

1. Gold is made from parts—icosahedra—that are 'finest' and 'the most nearly all of the same size', and it is therefore 'especially dense'.

2. *Adamas* is called 'the flower of gold', with the obvious implication that it is made from essentially the same kind of elements as is gold: it is, however, 'because of its density especially hard'.

Copper differs from gold in being made from parts that are of 'more than one kind' (59B6). The difficulty lies in determining Plato's precise intention in the comparison which he then makes between copper and gold.

Cornford translates, 59B7-C1:

'In point of density in one way' copper 'surpasses gold and it is harder because it contains a small portion of fine earth; but it is lighter by reason of containing large interstices.'

With this translation Cornford finds that:

'The structure of copper is somewhat obscure. How can copper be denser than gold, and yet contain larger interstices and so be lighter?'

He therefore offers two explanations. Copper may be 'denser', he suggests, 'in so far as icosahedra of different sizes can be more closely packed, the small ones helping to fill the interstices between the larger.' But to this he objects:

'If this were the only difference between copper and gold, copper would be nearer to the liquid condition and so the softer, and it would also be the heavier.'

Since in fact copper is both harder and lighter than gold, a different explanation is needed, and this Cornford finds in the admixture of earth.

'... The presence of earth makes copper actually harder than gold. Also there will be large interstices between the cubes and the icosahedra, which cannot be packed very closely; hence copper is somewhat lighter than gold.'²⁵

Neither explanation, I believe, is sound. The first contains an error of fact; the second, an error of translation. I take first the error of fact.

²⁴ Translation in part of the second passage, after my analysis, p. 93 below.

²⁵ *Cosmology* 251-2.

(ii)

It is true that we shall get more triangles into a single space, if we pack smaller icosahedra into the spaces between larger icosahedra. But we shall still not have as many triangles in the one space as we shall if we pack together a number of smaller icosahedra, all of the same size.

Now this second principle is the principle which must apply, or so it would seem, to the constitution of gold. In the account which Plato provides of the movement of the elements, the small elements are able to make their way in between the larger ones because of their 'fineness'.²⁶ In the account of gold therefore I take the 'finest' particles to be the smallest grade of the 'fusible'—as distinct from the 'liquid'—icosahedra. At the same time gold is made from 'parts that are most nearly of the same size'. On both counts therefore the elemental particles of gold are able to be, and Plato tells us that in fact they are, 'most closely packed' (πυκνότατον, 59B2).

In that case it will be impossible for copper to be '*more* closely packed' than gold, in the sense of having smaller icosahedra inserted in between larger ones.

I conclude that gold is heavier than copper quite independently of the presence in copper of cubes of earth. The smallness and the uniformity of the icosahedra of gold allow them to be more closely packed than the icosahedra of copper, which Plato tells us are not all of the same kind. This difference in density is sufficient reason for copper being lighter than gold.

But why then does Plato describe copper as '*more* dense' than gold? And how is it that copper is harder than gold?

(iii)

Copper is harder than gold because of the presence of earth.

A couple of pages after the comparison between copper and gold, Plato tells us that there are two causes of hardness. 'Density' is one reason. The presence of 'square faces' which will make a body 'especially stable' and 'very resistant' is a different reason. Plato writes, 62B8-C3: τὸ δὲ ἐκ τετραγώνων ὃν βάσεων, ἅτε βεβηκὸς σφόδρα, ἀντιτυπώτατον εἶδος, ὅτι τε ἂν εἰς πυκνότητα συνιδὸν πλείστην ἀντίτονον ἢ μάλιστα.

Both causes are employed in the present passage (59A8-C3):

1. *Adamas*, steel or diamond, is 'hardest because of its density': διὰ πυκνότητα σκληρότατον ὃν.

²⁶ 'Fineness': λεπτότητι, 58B2; cf. p. 88 above.

2. Earth is the only figure, in Plato's system, with 'square faces', and it is therefore the admixture of earth which will make copper harder than gold: γῆς μόριον ὀλίγον καὶ λεπτὸν μετασχόν, ὥστε σκληρότερον εἶναι.

Copper therefore is *lighter* than gold because the elemental particles are less closely packed; and it is *harder* than gold because of the presence within it of cubes of earth.

(iv)

Now Cornford recognises this second element in Plato's explanation, the association of hardness with the presence of earth, but his translation of the passage prevents him seeing that this is the *only* explanation which Plato offers of copper being 'denser' than gold.

For Cornford's translation introduces, in effect, three independent features into Plato's comparison of copper with gold: density, hardness and weight. But the structure of Plato's sentence indicates that there are essentially two factors of comparison only, hardness and weight, both of which are as it were subordinated to density.

This at least seems to be the explanation of the two clauses introduced by μέν and δέ, and given as explanation of the rubric πυκνότητι δέ. The meaning will be, not that copper is in general 'more dense' than gold, but that 'in respect of density' (πυκνότητι δέ) copper is *more dense* than gold in one way (μέν), and *less dense* than gold in another way (δέ).

1. Copper is *denser* than gold in one way, namely in so far as it contains a quantity of earth and is therefore *harder* (τῇ μὲν χρυσοῦ πυκνότερον ὂν ...).

2. On the other hand it is *less dense* than gold in another way, namely in so far as it has large interstices and is therefore *lighter* (τῷ δὲ μεγάλα ἐντὸς αὐτοῦ διαλείμματα ἔχειν κουφότερον).

Now it is at this point, I suggest, that there is a slight illogicality in Plato's account. There are, for Plato, as I have noted, two explanations of hardness: density and shape. What Plato has done, I suggest, is to associate density with hardness, even when hardness is in fact explained not by the elemental particles being closely packed, but by their having a certain shape. When therefore Plato writes that 'in one way' copper is 'denser' than gold, he will not mean that its primary particles are 'more closely packed'; for that, as I have noted, is impossible in fact. He will mean *only* that it is harder.

But in order to achieve, and to maintain, this simple bifurcation of the conception of density, we need to reconsider Cornford's translation of καὶ

γῆς. In Cornford's translation καί joins the two participle clauses: copper is denser *and* it is harder. Hence Cornford's need to provide two independent explanations: for density and for hardness. But the Greek can equally well mean, and I suggest does mean, that copper is denser than gold, in so far as it is harder, and that this is because it possesses earth in addition to (καί) the particles which it has in common with gold. I translate therefore, from 59B7:

'As regards density: copper is more dense than gold in one way, in containing in addition (*sc.* to the parts which are like gold) a small quantity of fine earth, which makes it harder; while at the same time, in virtue of having inside it large interstices, it is lighter.'

(v)

The point to appreciate is that, for Plato, 'density' has two connotations: hardness and weight.

1. The association of density with *hardness* is explicit in the account of *adamas*, which is 'especially hard *because of* its density (59B5).

2. The association of density with *weight* I suspect is implicit in the account of gold, which is, of course, strikingly heavy, and which Plato tells us is 'most dense' (59B2).

Therefore the difference of alignment, in a substance that is *heavier* and yet *softer* than another (as gold is, in the comparison with copper), faces Plato with a dilemma: is he to abandon the association of dense and *heavy*, or the association of dense and *hard*?²⁷

1. A long tradition of scientific thinking has accustomed us to weaken the *latter* association. For according to our modern conceptions, if one body is 'denser' than another, then it will invariably be *heavier*, whether or not it is *harder*.

2. Plato, in the passage I have quoted, chooses to weaken the *former* association. For according to Plato, copper is 'denser than gold in one way', namely in so far as it is *harder* than gold; but at the same time copper is *lighter* than gold, in so far as the particles from which it is made have larger interstices between them.

And yet—and herein lies the ambiguity—Plato chooses to weaken the association of 'dense' and heavy, in favour of the association of 'dense'

²⁷ Democritus, according to Theophrastus, faced a similar dilemma, which is inherent in the fifth-century association of dense and rare with heavy and light respectively: see Theophrastus, *De sens.* 62 (DK 68A135), and *cf.* vol. i pp. 367ff. See also the footnote following this.

and hard, only on a verbal level. For the explanation that Plato gives of 'hardness', in the comparison of copper and gold, is in fact related not to the elemental particles being close-packed, but to the shape of the particles of earth which are added to the substance that will be harder. Heaviness therefore continues to be aligned with density, in so far as the body which is heavier (gold, in the comparison between copper and gold) will have less void: in that sense—the modern sense—it will be 'denser'.

Hence the confusion for the modern reader:

1. The substance of Plato's explanation corresponds to our own association of 'dense' with heavy.
2. But the expression of Plato's theory reflects the alternative assumption, that a body which is harder than another must also be 'more dense'.

I conclude that, at this point, the complexity of Plato's theory proves to be largely a complexity of expression, and not of idea.

1. Plato does suppose that a body (gold) where the elemental particles are closer-packed will be the heavier, and *vice versa*.
2. But in the expression of his theory he still writes, at this one point, of the body which is lighter, and yet harder, as 'more dense'.²⁸

(vi)

This interpretation allows us to disengage cleanly from the comparison of copper and gold Plato's conception of weight as determined by density.

As I have noted, there are two causes of hardness:

1. Density: in the sense of things being 'close-packed'.
2. Shape: the square faces of the cubes which make up earth.

²⁸ There is a similar ambiguity in the atomic theory. In general, Theophrastus tells us (*De sens.* 62 = DK 68A135), what is dense is hard, and what is soft is rare. But how then does it come about that a body which is heavier may be softer, as lead is heavier and softer than iron? In their explanation, as recorded by Theophrastus, the Atomists retain the association of dense and heavy (lead is heavier because it has less void); while the difference of hard and soft they explain by the distribution of atoms (in iron the atoms are arranged 'unevenly'). And yet the Atomists are not altogether happy to abandon the correlation of what is hard with what is dense; for although in general iron has more void than lead has, nonetheless the particular consequence of the atoms in iron being distributed 'unevenly' is that 'in places they are more pressed together' (πεπυκνῶσθαι δὲ κατὰ ἔνια, *Dox.* 517.4-5).

The complexity in Plato results essentially from this same unwillingness to abandon the association of what is hard with what is dense, *even* in the comparison where the harder body is no longer heavier, and *even* when the decision has been made to retain the association of weight with density.

According to the *first* explanation, if one thing were denser than another, it would necessarily also be heavier, for if the triangles were 'more closely packed' there would necessarily be more of them: and according therefore to the principle of weight as defined by number the harder body would therefore also be the *heavier*.

But this does not follow on the *second* explanation. For on this explanation, it is the shape of the body which determines hardness: so that one body can be harder than another, and in that sense 'denser', while still having gaps between the primary bodies, and so having fewer triangles, and being *lighter*.

Thus the fact that gold is made from the 'finest' or 'smallest' grade of icosahedra, and also from icosahedra which are 'most nearly of the same kind', will explain why it is 'densest': for these are precisely the conditions which will lead to the icosahedra being most closely packed. On these conditions, copper cannot compete as it were. Gold is the 'densest', and therefore, one is probably intended to infer, the heaviest metal.

But it is not therefore also the hardest. Copper is the harder of the two metals, because it contains an admixture of earth, whose square faces are an independent cause of hardness. But because it is 'hard', and in this sense 'dense', copper is not heavier: for the presence of earth is consistent with, and perhaps requires there to be, internal gaps, whether between the icosahedra, or perhaps also between the cubes and the icosahedra, so that the resulting substance will have fewer triangles, and will therefore be lighter.²⁹

(vii)

Thus despite the unwonted intricacy, for the modern reader, in Plato's expression of his theory, nonetheless the more general conclusion, on Plato's conception of the role of density in relation to weight, is relatively straightforward.

Although Plato would appear to deny that there is empty space in the cosmos, his theory does not in practice prevent the existence of gaps or interstices between the elemental particles. This principle Plato employs in explaining differences of density and weight between copper and gold. Copper is composed of elements that are very similar to gold, but that are nonetheless of 'more than one kind'. In copper, the elemental particles therefore have gaps between them, and for this reason copper is lighter than gold.

²⁹ For the interpretations given of this passage by Martin and Taylor, and for the difference of reading at 59B7, see Note 6, pp. 366-8 below.

Thus in his account of copper Plato has added the notion of density to his initial conception of weight as determined simply by the number of elemental triangles within each of the geometrical solids.

I conclude that in the same way that in the atomic theory we distinguished the weight of individual atoms from the weight of complex bodies, composed of atoms and void, so now, in Plato's theory, we should draw an analogous distinction between individual tetrahedra, for example, and groups or agglomerations of tetrahedra.³⁰

From this point of view, Plato's definition of weight by number has been extended to include the association of weight with density. Essentially, fire is lightest because the tetrahedra which constitute fire have the smallest number of parts. However, weight is also determined by density, when we are dealing not with individual primary bodies, but with groups or agglomerations of them.

§ 4. PROBLEMS

(i)

It is true that Plato's theory does still occasion a number of difficulties.

Thus I concluded earlier that the difference in size between the different grades of elemental particle was reducible to a difference in the number of equal triangles. For example, the triangular faces of different grades of icosahedra would be made up from half-equilateral triangles that are all ultimately equal in size. It would therefore still be true that in this form of comparison, the comparison between different grades of the same element, the body with the smallest number of such triangles would be the lightest.³¹

Even so, there is still a difficulty if we compare different elements. A larger tetrahedron of fire, for example, might contain more of the smallest half-equilaterals than one of the smaller-graded icosahedra could boast of, and in that case some kinds of fire (made from a larger grade of tetrahedra) would presumably be heavier than some kinds of water (made from one of the smaller grades of icosahedra).

Is it Plato's intention therefore to compare, in effect, particles of fire and water that belong only to the same grade of triangle? Would Plato admit that, outside this comparison, a particle of fire, of one (larger) grade of triangle, could be heavier than a particle of water, from a different (smaller) grade of triangle?

³⁰ Cf. vol. i pp. 100-6, 345-6.

³¹ Cf. pp. 83-7 above.

(ii)

This problem is paralleled by the problem of the size of the elements.

Immediately preceding the definition of weight by number (56B1-2), the polyhedra which correspond to the three transformable elements are arranged in order of size: the smallest body goes to fire, the largest body to water, the 'middle' body to air (56A3-5).

This will be true, only if the triangular faces of these three polyhedra are the same, or at least not too disproportionate, in size.

There seems to be the same implication in Plato's account of the interpenetration of the elements (58A4ff.), where fire, air and 'the others' are arranged in order of 'fineness' (58A7-B2). Fire is the 'finest' element, and the implication still seems to be that it is therefore also the smallest element.

But between these two passages (56A3-5, 58A4ff.), we have Plato's announcement of differences in size for the two original triangles (57C7-D6). Are we to assume that Plato's account of the differences of size corresponding to the elemental particles will not apply, if the comparison is made between elements of more than one grade?

(iii)

One easy way to avoid this conclusion will be to suppose that there is an arbitrary limit on the range of sizes available to any one element, and that the triangular faces of even the largest grade of fire would be smaller, or not much larger, than the triangular faces of even the smallest grade of air or water.

If we adopt Cornford's thesis, this will mean that the number of smallest half-equilateral triangles ultimately contained in any particle of fire, no matter how large, would be smaller than the number of such triangles entering into the composition of any particle of air or water, no matter how small.

Fire, even fire of the largest grade, would then still be the 'smallest' element (*cf.* 56A3-4). And it would still be the 'lightest' element, in being made from 'the smallest number of like parts' (*cf.* 56B1-2).³²

³² 'The triangular faces of even the largest grade of fire would be smaller, *or not much larger*, than the triangular faces of even the smallest grade of air or water.' For example, if the triangular faces of the tetrahedron were made each from eight half-equilaterals, and those of the octahedron from six half-equilaterals, then each face of the tetrahedron would be *larger* than each face of the octahedron, but, as measured by the total number of half-equilaterals, the tetrahedron (with 32 half-equilaterals in all) would be *smaller* than the octahedron (with 48 half-equilaterals in all). But obviously, without an arbitrary limitation of size, *some* grades of tetrahedra could contain a larger number of 'equal' half-equilaterals than an octahedron or icosahedron of one of the smaller grades.

(iv)

This is in principle the solution proposed by Martin.

Martin is troubled, not by the problem of weight, but by the problem of size. He writes, of the passage where Plato introduces differences of size for the different kinds of each element (57C7ff.).

‘Pour concilier ce passage avec celui où il a été dit que les éléments de la pyramide, de l’octaèdre et de l’icosaèdre étant les mêmes, celui de ces trois corps qui a le plus d’éléments est nécessairement le plus grand, il suffit de supposer que les grandeurs des éléments ne peuvent varier que dans certaines limites, de sorte qu’aucune pyramide ne soit plus grande qu’un octaèdre, et qu’aucun octaèdre ne soit plus grand qu’un icosaèdre.’³³

In writing of the ‘elements’ or triangles as ‘the same’, Martin means to compare initially polyhedra which are all of the same grade. This is fairly clearly Plato’s own intention, both in his initial account of fire as the ‘smallest’ body (55E7ff.), and earlier in his construction of the geometrical solids (55D7ff.). In both passages, we compare polyhedra made from the same grade of triangle: fire therefore is the ‘smallest’—and the ‘lightest’—body, simply because the tetrahedron is the smallest of the three transformable polyhedra, provided that the three polyhedra are all of the same grade, i.e. provided that their faces are made up from the same number of equal half-equilaterals and are therefore all ‘the same’ in size.

It is obvious that the triangles or ‘elements’ are no longer, in this sense, ‘the same’, when Plato introduces polyhedra which are not all of the same grade (57C7ff.). Martin’s solution is to suppose that in this later passage there is an arbitrary limitation attaching to the range of sizes that are possible for each of the three polyhedra, so that even in this later passage fire, for example, will still be the ‘smallest’—and, we may add, the ‘lightest’—of the three transformable polyhedra.

Cornford’s thesis adds to Martin’s solution the refinement that the comparison between polyhedra of more than one grade can still be expressed in terms of number, if we choose the smallest size of half-

³³ Thomas H. Martin, *Études sur le ‘Timée’ de Platon* ii (Paris, 1841) 254. The passage where ‘il a été dit que les éléments de la pyramide, de l’octaèdre et de l’icosaèdre étant les mêmes, celui de ces trois corps qui a le plus d’éléments est nécessairement le plus grand’ is presumably the passage where in fact Plato says that fire is *lightest* because it has the *fewest* number of like parts (56B1-2; see p. 81 above), although it is true that the passage as a whole gives the sense which Martin requires (for size, see esp. 56A3-5).

It is worth noting that even the large range of sizes required by Martin’s solution would not necessarily raise the problem of the visibility of the triangles (cf. Note 4, pp. 341-5 below); it is open to Plato to have an indefinite range of sizes, all below the threshold of visibility.

equilateral common to the polyhedra in question. For in this sense the 'elements' or triangles are 'the same' even between polyhedra of more than one grade.

With Martin's restriction on the relative sizes of polyhedra of more than one grade, it would therefore still be true that the tetrahedron of fire would be made from 'the smallest number of like parts'. In the comparison between polyhedra of more than one grade, this would mean that the number of smallest half-equilaterals in even the largest grade of tetrahedra would be smaller than the number of half-equilaterals of the same size in even the smallest grade of octahedra or of icohedra.

The difference between the two formulations is simply that in the comparison between polyhedra that are all of the one grade the tetrahedron is necessarily made from 'the smallest number of like parts', whereas in the comparison between polyhedra of more than one grade this is true only if we arbitrarily restrict the range of sizes between the different grades of polyhedra, so that even the largest tetrahedron is smaller than even the smallest octahedron or icosahedron.³⁴

(v)

On Martin's solution, we can preserve the relations of size and weight which Plato has established for polyhedra of the same grade (55E7ff.), in the comparison between individual polyhedra of more than one grade (*cf.* 57C7ff.).

³⁴ I labour the obvious, simply because of the confusion that has already surrounded Martin's statement of his thesis. Thus John Cook Wilson objected that Martin's formulation (*les éléments ... étant les mêmes*) would prevent the polyhedra of any one kind from differing in size, *On the interpretation of Plato's 'Timaeus'* (London, 1889) 50-1; he concludes that both Plato's original theory and Martin's interpretation of it are inconsistent. But this is a quibble; Martin's intention is precisely to reconcile Plato's initial statement of his thesis (*les éléments ... étant les mêmes*, *cf.* 56A3ff.) with the later account of differences in size (57C7ff.).

Taylor, *Commentary* 393-5, attempted to defend Martin against Cook Wilson, but his discussion wanders off into the comparison of volumes, with some very unhappy consequences. Taylor writes, for example, that Plato's initial comparison between the sizes of the three polyhedra (56A3-5) 'would be obvious to an intelligent child from the simple consideration that these relations are visibly true of the three when inscribed in the *same* sphere' (*Commentary* 394). But if the three polyhedra are inscribed 'in the *same* sphere' (Taylor's own italics) then we have the quite unnecessary complication not only that the triangular faces of the three polyhedra will differ in size, but that the order of magnitude will be *reversed*: the tetrahedron will have the largest faces, and the icosahedron will have the smallest faces. Taylor's illustration sheds darkness on one of the few places where there was light before.

I hope it is clear that I repeat Martin's interpretation as only a possible interpretation of Plato's text. Archer-Hind tells us that Martin's solution is 'obvious' (edn 207); but what is 'obvious' as a piece of mathematics is not at all obviously Plato's own intention.

A different solution is possible if we limit ourselves to the comparison between groups or agglomerations of tetrahedra, and exploit the principle I have established for the comparison of copper and gold (*cf.* 59A8ff.).

For Plato might suppose that the 'gaps' between the polyhedra are such that the number of equal triangles in any quantity of fire is always less than in any equivalent quantity of air or water. Thus although the individual tetrahedron, of one (larger) grade of triangle, might have more triangles than an icosahedron, of a different (smaller) grade of triangle, nonetheless the icosahedra might be so packed as to have more triangles in the whole volume of water than in the whole volume of fire.³⁵

(vi)

Admittedly, once we start on the comparison of volumes, the difficulties in Plato's theory increase rather than diminish, even if we compare particles that are all of the same grade.

For example, taking the examples of wood and lead from Aristotle's account of Plato's theory, Zannoni writes:

'Il piombo, a parità di volumi, sarebbe più pesante dal legno perchè la diversa figura geometrica delle molecole permetterebbe al volume di piombo di contenere una maggior quantità di materia che non contiene il volume eguale di legno.'³⁶

What Zannoni appears to have done here is to compare not the number of triangles, but the volume of the different geometrical figures. Although it is not Zannoni's intention, this highlights another difficulty in Plato's scheme. For if we compare from this point of view an icosahedron and a tetrahedron then the result is exactly the opposite of what Plato's theory requires.

For the space occupied by an icosahedron, with 20 triangles, will contain, if it is closely packed, no less than 20 tetrahedra of the same grade (i.e. each face of the icosahedron leaves room for the base of one tetrahedron of the same grade, pointing inwards as it were): so that the volume of an icosahedron, if filled with tetrahedra, would contain no less than 80 triangles in all.

³⁵ It is possibly worth noting that at one point Plato does say that the largest particles have the largest 'emptiness' between them (58B2-4). Will this imply that tetrahedra made from a larger grade of triangle will therefore have larger gaps between them than icosahedra made from a smaller grade of triangle? Possibly. But in the context the rule seems rather to presuppose the differences of size that had already been established for the various polyhedra, independently of the differences of grade (*cf.* 55D7ff.): the meaning will then be simply that icosahedra have larger gaps than tetrahedra.

³⁶ *De caelo* edn 184 n. 2 (= 188). Wood and lead: Arist. *De caelo* iv 2, 308b9-10.

Thus if density is determined solely by shape, as Zannoni in effect supposes (*cf.* 'la diversa figura geometrica ...'), then a body made from particles of fire would invariably contain more triangles, and should therefore be heavier, than a body made from particles of water.

But again the result need not follow, thanks to the principle contained in the comparison of copper and gold. For Plato evidently does not suppose that there are no spaces between each of the elemental particles. It is therefore open to Plato to suppose that the particles are arranged in such a way that in any accumulation of tetrahedra there will in fact be fewer triangles than in any equivalent volume of icosahedra.³⁷

(vii)

But I have gone far enough. I am not at all sure that Plato's theory was intended to satisfy this kind of scrupulosity. These may well be problems which Plato has been able to overlook, or anomalies which he has been willing to accept.

Thus the two main problems that I have introduced are both hypothetical.

1. Does Plato suppose that fire remains the 'lightest' element, even when the faces of the tetrahedron are made from one of the larger grades of triangle?
2. Does Plato recognise that tetrahedra, if closely packed, would contain more triangles than an equivalent volume of icosahedra?

These are both problems that Plato may not have seen, or may have chosen not to deal with. On the other hand, possible solutions do exist.

1. There may be an arbitrary limitation on the different grades of triangle, so that tetrahedra even of the largest grade are smaller even than octahedra of the smallest grade.
2. It need not follow that the particles which can be closely packed are so, nor therefore need it follow that, volume for volume, the space occupied by a cluster of tetrahedra, for example, would contain

³⁷ Unfortunately, this problem is exacerbated by the rule noted earlier, whereby the largest particles have the largest 'emptiness' between them (58B2-4; *cf.* p. 100 n. 35 above). For if this rule is applied to particles of the same grade, then there will be larger gaps between icosahedra than between tetrahedra.

In his introduction, p. 48, Zannoni does distinguish 'la diversa grandezza delle molecole stesse' and 'la loro maggiore o minore radezza nell'agglomerato'. But Zannoni is here writing not of the *Timaeus*, but of the theory which Aristotle introduces later in the *De caelo*, where weight is defined 'by large and small' (iv 2, 309b29-310a13). I have not probed the question raised by Zannoni's use of 'materia'. For my present purposes, I have interpreted this solely in terms of the number of triangles; what might be 'inside' the primary solids is another question.

more triangles than the space occupied by a single icosahedron, made from the same grade of triangle.

The difficulties inherent in Plato's conception, and possible solutions to them, could be taken further. For the moment, I conclude simply that Plato's definition of weight by density adds some flexibility to the definition of weight by number, rather than being in any way intended to conflict with it or to supplant it.

§ 5. PERSPECTIVES

I conclude that there are two theories of weight in Plato: a preliminary theory (53Cff.), where weight is explained by number and by density, and a more elaborate theory (62C3-E8), where weight is explained by direction and resistance.

(i)

The theory of weight as defined by number turns on Plato's conception of the primary elements as formed from, or as corresponding to, four primary regular bodies, which themselves are made up from two kinds of triangle. Plato tells us that the regular body with the smallest number of sides, which is the tetrahedron, constitutes, or corresponds to, fire, which is therefore the lightest element, in being made from 'the smallest number of like parts'.

The complication arises when we are told, a few pages later, that as well as there being different regular bodies for the four elements, there are different sizes of the triangles which compose these regular bodies, and therefore different sizes of each kind of regular body corresponding to varieties within each of the four elements.

This refinement of Plato's theory would seem to supplant the definition of weight by number with a definition of weight by size: for presumably a body with the least number of surfaces will now no longer be the lightest body, unless its surfaces are also made from the smallest size of triangle. A body with larger and fewer triangles might even, we could suppose, be heavier than a body with more triangles, but smaller ones.

An initial solution to this problem is provided by Cornford's thesis that the larger triangles are reducible to smaller ones. In order for all the elements to be transformable, with the exception of earth, and not only for one grade of one element to be transformable into the equivalent grade of another element, the triangles which are truly elemental are the same in size as in kind.

Cornford's interpretation makes good sense of Plato's theory. But it lacks any very explicit statement from Plato himself. When Plato is silent, the testimony of Aristotle is the next best evidence we can hope for. Unless Aristotle's presentation of Plato's theory is unusually lax or untypically indulgent, then it does imply that the definition of weight in terms of 'equal' triangles will be true for all varieties of sensible substance, and therefore even for different grades of polyhedra.

This will be so on Cornford's thesis, where differences of size can be expressed as a difference in the number of smallest triangles. The definition whereby the 'lightest' body is made from 'the smallest number of like parts' (*cf.* 56B1-2), in Plato's initial context will refer to polyhedra all of the one grade. But with Cornford's thesis the same formula could be adapted to the comparison of polyhedra of different grades, where the 'like parts' would be the smallest half-equilaterals or the smallest half-squares common to the different polyhedra.

Whether, in such a comparison, fire would still be the 'smallest' and the 'lightest' element is problematical. The problem could be solved, by supposing that there are arbitrary limits to the range of possible sizes for each of the polyhedra, or by suppositions about the density of groups or agglomerations of polyhedra. But it is not clear how far Plato means us to go in raising these difficulties, and in exploring possible solutions to them.

(ii)

Weight defined by number is accompanied by an explanation of weight in terms of density.

This explanation appears especially in the comparison of copper and gold. Copper is constituted from essentially the same kind of primary bodies that gold is, but it is lighter because in copper there are larger interstices between the primary bodies.

At the same time, Plato is able to conclude that copper is harder than gold, and in that sense 'more dense' than gold, not in virtue of the number of triangles which any quantity of copper may contain, but because of the admixture of earth. The square faces of the cubes which constitute earth add to the resistance and so to the hardness of copper, without adding proportionately to its weight.

The theory of weight as dependent upon density is obviously an immediate corollary to the definition of weight by number. The point is simply that when Plato defines weight by number he is dealing with a single primary body, whereas when weight is made dependent upon density we have to consider not only the individual primary bodies but their

disposition in relation to each other within some larger grouping or agglomeration of the primary bodies.

The number of elemental triangles is relevant, therefore, not only in the calculation of the individual icosahedron or tetrahedron, of whatever size or grade, but also in the calculation of the distribution of the primary bodies within the constitution of different varieties of sensible substance.

(iii)

The theory of weight as related to direction, and as measured by resistance, turns on the axiom that heaviness is determined by the movement of a body towards its parent element. Thus Plato tells us that a larger quantity of earth or of fire, measured at the centre and the circumference respectively, since by implication it moves towards its parent body with greater force than a smaller quantity of either element, must therefore be reckoned as being heavier, and as moving 'downwards', i.e. towards its like, while the smaller quantity, by comparison, is light, and moves 'upwards', i.e. away from its like, the more easily.

Plato deals explicitly only with fire measured at the circumference and with earth measured at the centre. Whether Plato's final definition (63E3-7) is intended deliberately to embrace the converse circumstance, of fire measured at the centre and of earth measured at the circumference, we cannot tell with certainty.

But if we are to extend the theory, to include these further calculations, then to conform to Plato's final definition, the conclusion, I have argued, must be that a larger quantity of fire, measured from the centre, or a larger quantity of earth, measured from the circumference, is still intended to be heavier than a smaller quantity, while the smaller quantity, in either case, is reckoned as being lighter, because in either circumstance Plato envisages us as measuring the resistance which fire or earth would offer if we try *to prevent* either element *returning* to its like. This way of looking at the possible extension to the theory provides a natural parallel, I have argued, to our measuring the resistance which fire or earth will offer, when we try *to drag* either element *away from* its parent body, which is the only circumstance which Plato himself describes.

Only if we do take Plato to be measuring resistance in both cases, fire and earth measured at the centre as well as at the circumference, are we able to justify, for either circumstance if necessary, the definition that 'the one thing to hold in mind in every case' is that 'the journey of an element towards its parent body makes the body which moves towards its home heavy' (63E3-7).

(iv)

In the chapters which follow, I shall turn therefore to the obvious question, the correlation of the two theories, of weight as defined by number and by density, and of weight as defined by direction and by resistance. How far do these two theories coincide, and how far, if at all, are they reconcilable?

It would be possible perhaps to give some kind of immediate answer: as that the earlier theory is intended to provide the objective correlate for the later theory; or that the earlier theory is intended to explain weight in the macrocosm, while the later theory is intended to explain weight within the world of human, or at least of animate, perception; or that the earlier theory is a concession to earlier conceptions of weight, and represents therefore a stratum of traditional thinking in the *Timaeus*, whereas the later theory is adapted to Plato's own intuitions of the significance of position and movement within a cosmos that is one and eternal.

I do believe that these proposals are in fact true, or at least represent part of the truth. But a summary presentation of the relation of the two theories would inevitably fail to carry conviction against the opinion of those scholars who are now most eminent in the field, Solmsen and Cherniss, both of whom, as I noted earlier, consider the earlier theory to be a trivial addition to Plato's account of the elements, with no real relevance to the later theory of weight as defined by resistance.³⁸

At the same time, so summary an answer would fail to uncover at all fully or convincingly the extent and the complexity of the conceptual framework within which, I believe, Plato intends to place not only the two theories of weight which I have outlined, but a whole series of parallel, and related, oppositions.

For initially the point to appreciate, in considering the relation of Plato's 'two' theories of weight, is that weight is not the only instance where there are 'two' theories. There are 'two' theories of hot and cold, and of hard and soft, and of sweet and sour.

For the duality in Plato's conception of weight is symptomatic, I shall hope to show, of Plato's whole conception of the relation between perceived object and percipient, of the relation between the primary particles and our perception of their impingement upon us.

(v)

Thus a full, and inevitably therefore a fairly long, analysis will be needed in order to uncover, and to establish, the conceptual framework

³⁸ Cf. p. 79 above.

within which, I believe, Plato's two conceptions of weight can be seen to be harmonised in the way that Plato himself intended.

For this conceptual framework, which is central to an understanding of the *Timaeus*, has been missed not only by Solmsen and Cherniss, both of whom are concerned with the *Timaeus* only as part of a broader study. It has also, I believe, failed to register, for rather different reasons, with either of the two most authoritative modern exponents of the *Timaeus* as a whole: Taylor and Cornford.

Cornford's failure is, I think, untypical of a commentary which in many places is perceptive and convincing. But on the question I have in mind, Cornford was over-preoccupied with his earlier study of the *Theaetetus*, and attempted too brusquely to tie in Plato's account of sensation and perception in the *Timaeus* with what Cornford supposed—I believe rightly—to be Plato's own theory of the interdependence of perceived object and percipient in the *Theaetetus*.

Taylor's failure to master the issues in question is more typical. In this area, as elsewhere in the *Timaeus*, Plato's ideas are either subordinated to Taylor's conceptions of fifth-century Pythagoreanism, instantiated in the person of a supposedly historical 'Timaeus', or alternatively, when Plato's ideas manage to resist this treatment, by being obviously more sophisticated than anything we have evidence for earlier, they are blown up into a scantily veiled surrogate for the philosophical categories of Whitehead.

Thus although useful details emerge from Taylor's commentary, any more general orientation of Plato's thinking can rarely hope to escape both the fires of a supposedly historical 'Timaeus' and the watery wastes of *The concept of nature* or *The principles of natural knowledge*.

A careful reappraisal will be needed therefore of the precise scope and nature of Plato's theory of the interrelation of substance and sensation in the structure of the *Timaeus*, before we can return, with any real hope of success, to the conciliation of the two theories, of weight as defined by number and by density, and of weight as measured by direction and by resistance.

CHAPTER SIX

SUBSTANCE AND SENSATION IN THE STRUCTURE OF THE 'TIMAEUS'

§ 1. 'GENE' AND 'PATHEMATATA'

I start with a brief account of the position that the two theories of weight occupy in the structure of the *Timaeus* as a whole. I do so, not in order to be original; but simply to provide an initial orientation for the necessarily rather detailed discussion that follows, and for the final attempted conciliation of the 'two' theories of heavy and light. For my conclusion will be that the distinction between the two theories of weight is only a marginally more complex instance of the distinction that Plato sees between substance and sensation or—more precisely—between *gene* and *pathematata*, in the structure of the *Timaeus* as a whole.¹

(i)

The *Timaeus* is divided, deliberately, into three parts which may be labelled roughly the works of reason, the products of necessity as guided by reason, and the powers of reason in the persuasion of necessity.

The *first* part of the treatise turns on a division of existence into an invisible world of timeless and unchangeable reality, and a world of becoming and of visible appearance. On the basis of this distinction Plato describes the formation of cosmic soul and of the souls of men. Cosmic soul animates the whole universe, and in particular the bodies of the stars. The souls of men acquire a knowledge of truth and order by being able to see these same 'visible gods'.

The *second* part of the treatise also concludes with an account of sight, but arrived at from the opposite direction, so to speak: from the division of existence into forms and their images within the receptacle of becoming, whose 'wandering motions' introduce a residuum of unreasoned necessity into the final ordering of the cosmos.

¹ Here and in what follows I employ the term 'substance' in full recognition, I hope, of its Aristotelean provenance and of its inappropriateness to Plato's conception of the occupants of the receptacle. On the other hand, I know of no other more convenient term, to avoid the constant transliteration of *genos* or *eidos*, and awareness of the potential dangers will I hope be sufficient to insulate my use of the term against confusion or error. The desire of some French purists to forego any use of 'substance' when writing of Greek philosophy, and even of Aristotle, seems to me merely foolish.

The *third* and final part of the treatise describes the housing of the mortal part of soul within the human frame, and the bodily processes which sustain or impede the functioning of soul and body.²

(ii)

Both theories of weight fall within the second part of Plato's treatise.

From the 'wandering movements' of the 'nurse of becoming', where there exist footprints or traces only of the four elements, 'such as there might appear when god is absent from the world', there are constructed, by the addition of 'shapes and numbers', the geometrical solids which will correspond to the four Empedoclean elements or *gene*. It is in the course of establishing the correspondence between the geometrical solids and the Empedoclean elements that Plato introduces the equation of weight with number: the lightest element is the figure with the smallest number of parts.³

From the shapes and numbers or sizes of the primary bodies Plato derives the transformation of the elements and their distribution within the cosmos. This part of the treatise concludes with two final topics: a list of the secondary substances, *gene* or *eide*, which are formed from the four major elements or *gene*; and a parallel account of the effects, the *pathemata*, which these same substances produce upon the sensible percipient.⁴

The secondary substances, *gene* or *eide*, are listed according to their derivation from the primary kinds of each element. Of *fire*, there are many *gene*, of which examples only, Plato tells us, are flame, light and 'glow'. From *air*, there are derived mist, darkness, and 'other unnamed *eide*'. From *water*, which is essentially of two kinds, there are derived on the one hand metals, gold, *adamas* and copper; and from the other kind, hail, ice, snow and frost. From *earth*, finally, there come crystal, rock, earthenware, lava (possibly—the sense of the word is uncertain), soda, salt, glass and 'fusible stone', wax and incense.⁵

The *pathemata* which these substances produce upon the sensible percipient are divided into '*pathemata* that are common to the whole body' (64A2-3: τῶν κοινῶν περὶ ὅλον τὸ σῶμα παθημάτων, and 65B4: τὰ ... κοινὰ τοῦ σώματος παντὸς παθήματα), and '*pathemata* that depend upon particular

² The three parts: 27D to 47E, 47E to 69A, 69A to the end.

³ The 'wandering movements' of the 'nurse of becoming', 47Eff., esp. 48A6-7, 49A5-6, 52D4-5. Footprints etc., 53B1ff. 'Shapes and numbers', 53B5. The construction of the geometrical solids, 53C4ff. Their correspondence with the Empedoclean elements or *gene*, 55D6ff. ('the four *gene*', 55E1). Weight and number, 56B1-2.

⁴ *Gene* or *eide*, 58C5-61C4. *Pathemata*, 61C4-68D7.

⁵ Fire, 58C5-D1. Air, 58D1-4. Water, 58D4-60B5. Earth, 60B6-61C2. Some of the substances are formed from a combination of more than one element; but Plato lists them as I have done, according to the element which is dominant.

parts of the body' (65B6-7, τὰ ... ἐν ἰδίοις μέρεσιν ἡμῶν γιγνόμενα, τὰ τε πάθη καὶ τὰς αἰτίας αὐτῶν δρώντων). The common *pathemata* are hot and cold, hard and soft, heavy and light, rough and smooth, and pleasures and pains. The particular *pathemata* correspond to the four senses (i.e. excluding touch); they are therefore flavours, smells, sounds and colours. Thus it is in the account of the common *pathemata* that heavy and light are defined by resistance.⁶

(iii)

In the following sections of this chapter, the point to appreciate will be that heavy and light are not alone in appearing twice in the central section of the *Timaeus*, i.e. both in Plato's account of the elements as they exist in the world at large, the *gene* or *eide*, and within the account of *pathemata*. There will prove to be the same repetition in Plato's analysis of hard and soft, of hot and cold, and of sweet and sour.

For Plato's purpose, essentially, is to show that the principles and processes which explain the formation and the behaviour of the substances or *gene* are repeated in our sensible perception of these same substances.

For the moment, however, I limit myself to establishing the particular instances which there exist of repetition, between Plato's account of the *gene* and his account of the *pathemata*, before turning to a more precise analysis of what it is that Plato intends by the use of the word *pathema* or *pathos*, and how it is that this conception, and the correspondences that there exist between *gene* and *pathemata*, are intended to reconcile the two theories of weight, as defined, among the *gene*, by number and density, and as defined, among the *pathemata*, by direction and by resistance.

§ 2. HARD AND SOFT

I take first the example which perhaps most plainly shows Plato's intention, that of hard and soft.

Plato thus defines hard and soft among the *pathemata*, in the sentences immediately preceding his account of heavy and light as aligned with direction and as defined by resistance, 62B6-C3: σκληρὸν δέ, ὅσοις ἂν ἡμῶν ἡ σὰρξ ὑπείκη, μαλακὸν δέ, ὅσα ἂν τῇ σαρκί· πρὸς ἄλληλά τε οὕτως· ὑπείκει δὲ ὅσον ἐπὶ σμικροῦ βαίνει· τὸ δὲ ἐκ τετραγώνων ὃν βάσεων, ἅτε βεβηκὸς σφόδρα, ἀντιτυπώτατον εἶδος, ὅτι τε ἂν εἰς πυκνότητα συνιὼν πλείστην ἀντίτονον ἢ μάλιστα.

⁶ The common *pathemata*, 61D5-65B6. The particular *pathemata*, 65B6-68D7. Heavy and light defined by resistance, 62C3-63E8.

I paraphrase:

“‘Hard <is the name given> to whatever things our flesh will yield to. “Soft” <is the name given to> whatever things yield to our flesh. And the same is true <of things called “hard” and “soft”> in relation to each other.

‘Whatever stands on a small base, yields <and is called “soft” therefore>.

‘Whatever is made from square bases, precisely because it stands especially firm, is the kind of thing that is most resistant <and that is called “hard” therefore>. And the same is true of anything that has turned in upon itself, so as to achieve maximum density, and is therefore especially resilient.’

(i)

‘Something is hard if our flesh yields to it; something is soft if it yields to our flesh.’ So much is simple enough. What is distinctive, and essential, is the addition, πρὸς ἀλλήλα τε οὕτως: ‘such they are also in relation one to another.’ The point of this is that although hard and soft are included in our human perceptions they are apparently not peculiar to them. Hard and soft, defined as resistant and as yielding, have already been introduced as existing among the *gene*, or as we might say ‘in the world outside’. It is in this sense that they exist ‘also in relation to one another’.

Thus if we look back to the account of the *gene* we discover that softness has been exemplified in the account of water. The more liquid of the two kinds of water, from which hail and ice, snow and frost are formed, is ‘soft’ in relation to earth, which is probably intended to include rock or stones, 59D4-7: τὸ πυρὶ μεμειγμένον ὕδωρ, ὅσον λεπτὸν ὑγρὸν τε διὰ τὴν κίνησιν καὶ τὴν ὁδὸν ἣν κυλινδούμενον ἐπὶ γῆς ὑγρὸν λέγεται, μαλακὸν τε αὐτῷ τῷ τὰς βάσεις ἥττον ἐδραίους οὕσας ἢ τὰς γῆς ὑπείχειν ...

I paraphrase:

‘Water mixed with fire:— <water> which, fine and fluid, is called fluid because of its movement, because of the course it follows as it rolls along the ground,— <water> which is soft because its bases are less stable than those of earth, and so give way <to earth> ...’

We had already been told that the more fluid of the two kinds of water was especially mobile for two reasons: (1) because the particles from which it is made are small and ‘unequal’, and (2) because of ‘the nature of its shape’ (58D4-8). These two features I take to be repeated in the present account (59D4-7). The water in question is ‘fine’; this I take to be equivalent to Plato’s earlier specification that the particles from which it is composed are *small*. It is also fluid, ‘because of the course it follows as it rolls along the ground’. This I take to be a consequence of the *shape* which

water has: an icosahedron will indeed 'roll' more easily than a cube, a tetrahedron or an octahedron, the figures which represent earth, fire and air.

What we now learn (59D4-7) is that this water is 'soft' in relation to earth, because its surfaces are less stable than those of the cubes from which earth is made. The point I take to be that this is water more or less in the everyday sense, whereas the other kind of 'water' exists only, or at least primarily, as metals. This kind of water therefore is mobile: it 'rolls' over the ground. And it is soft in the sense that in doing so it flows around, and so 'gives way' to earth or stones that find themselves in its path.⁷

(ii)

If water is soft because its surfaces are 'less stable' than are those of earth, then earth, by contrast, should be hard.

The hardness of earth has in fact appeared in the account of the metals. Copper, I have already noted, in my account of weight as defined by density, is lighter than gold, because it has large interstices, but it is 'denser than gold in one way', because it contains an admixture of earth, and is therefore harder.⁸

But there is a second cause of hardness which Plato also adduces in his account of metals.

1. The square surfaces of earth explain why copper is harder, and in that sense denser, than gold.
2. 'Adamant' is hard for another reason. It is 'especially hard because of its density', 59B5: διὰ πυκνότητα σκληρότατον.

⁷ Cornford complains, *Cosmology* 248-9, that at 58D4-8 the shape of the particles is 'strictly irrelevant' since both kinds of water, the liquid and the fusible, are made from the same shape, the icosahedron, and neither kind of water should therefore be any more 'mobile' than the other. But we need to appreciate (1) that at 58D4-8 Plato already has one eye on the comparison that will be given of water and stones at 59D4-7, and (2) that the inherent mobility due to the shape of the icosahedron is so to speak cancelled out in the case of metals by the fact that the particles of the fusible kind of water are 'large and uniform' and that this kind of water is therefore 'more inclined to be stationary' (58D8-E1).

'Inequality' as cause of mobility is picked up in the later passage not by the particles of water being themselves 'unequal' (cf. 58D6-7), though no doubt this will still be true, but by the presence of fire (59D4), which in the account of metals we had been told was 'the demiurge of unevenness' (59A5-6), and which is therefore the cause of movement (cf. 57E6-58A1). Fairly obviously, fire has the same effect in 'liquid' water as in metals (cf. 59D7ff.).

⁸ 59B6-C3: see above pp. 89-96.

Now these *two* causes of hardness correspond precisely to what Plato will tell us later, in his account of the *pathemata*, in the passage quoted at the head of this section (62B6-C3).

1. A body will be hard if it possesses square surfaces.
2. It may also be hard as the result of extreme density.

It is obvious therefore, it seems to me, that Plato's account of copper and adamant is intended to exemplify the two causes of hardness which will be spelt out in a more generalised and abstracted form in the account of the *pathemata*; or, to put it the other way round, that the two causes of hardness specified in the account of the *pathemata* are intended to summarise, and to generalise, the description that Plato had already given of the hardness of copper and of adamant.

(iii)

It seems clear to me that Plato intends to give a coherent and consistent account of hard and soft in his analysis of the *gene*, even before his explicit definition of hard and soft in his analysis of the *pathemata*.

1. Adamant is hardest because of its density.
2. Copper is harder than gold, because it has an admixture of earth.
3. Water, of one type, is soft, because its surfaces, i.e. the surfaces of the icosahedra from which it is formed, are 'less stable' than are those from which earth is made, and it therefore 'gives way' to earth.

The requisite principles are then articulated in the account of the *pathemata*. Something is hard, either because it is densely packed, as in the *first* instance cited above, or else because it has rectangular surfaces, as earth has in the *second* and *third* instances. Conversely, something is soft if it 'yields', precisely as water is said to do in the *third* instance.

The only novelty, therefore, in Plato's account of hard and soft as *pathemata* lies in his extending the comparison of two substances 'one to the other' (πρὸς ἀλλήλα) to include the circumstance where one substance is human flesh.

1. Water is soft because it yields to earth or rock; rock, we may infer, is hard because it will not yield to water.
2. So too, something is soft if it yields to our flesh; while something is hard if our flesh must yield to it.

The two processes are identical therefore. The only point of difference is that a process which applies independently in the world of the *gene* recurs

in Plato's analysis of the *pathemata*, where one of the factors implicated is the human body, or at least our flesh.

§ 3. HOT AND COLD

(i)

The same correlation is obviously intended to exist between the action of fire in the outside world and the sensation or perception of heat.

When the tetrahedron is assigned to fire, we are told that it is the 'sharpest' figure (ὀξύτατον, 56A5). The same feature recurs in the account of the transformation of elements. When a large quantity of fire surrounds another element, it cuts it up 'by means of the sharpness of its angles and the sharpness of its edges', 56E8-57A2: ὅταν ἐν πυρὶ λαμβανόμενον τῶν ἄλλων ὑπ' αὐτοῦ τι γένος τῇ τῶν γωνιῶν καὶ κατὰ τὰς πλευρὰς ὀξύτητι τέμνηται ... The two reasons are at once apparent from any model of the regular solids. The angles of the tetrahedron are indeed more pointed, to use a layman's language, and its edges are sharper.

Precisely the same two features are resumed in the account of heat as a *pathema* (61D5-62A5). 'We all recognise', Plato tells us, 'that heat is a sensation of sharpness' (ὀξύ τι τὸ πάθος), precisely the word that had twice been used in the account of the *gene*. The reasons which Plato gives again include 'the fineness of its edges' and 'the sharpness of its angles'. The fact we need now to appreciate is that this 'splitting and cutting action takes place upon our own body'. It is the tetrahedron which 'chops our bodies up into little pieces'. This action, Plato tells us, explains 'the *pathema* and the name' of 'what we now call "hot"' (62A4-5).⁹

Plato's principle is very simple. It is precisely analogous to his analysis of hard and soft. The very same properties and processes which exist and are at work in the world at large, the 'sharpness' of fire, its 'cutting up' other elements, are repeated in the human body. The *pathema* which we experience is no more than the occurrence within our own body, or in relation to our own body, of processes which have already been established as at work in the world at large.

(ii)

Mutatis mutandis, the same is true again of the converse process of growing cold.

Take first the cooling and solidification of metals, in Plato's account of the *gene* (59A1-8). When a metal is heated, it melts. When the fire which

⁹ For the text of this passage, cf. pp. 372-3 below.

has caused this escapes, 'since there is no void for it to enter', it compresses the surrounding air, which in turn forces the particles of the metal, which are still in a fluid state, back into the gaps left vacant by the fire. The metal is thus 'restored to its earlier uniformity', whether simply by the removal of fire, or perhaps also, as Cornford believes, by the reformation of smaller octahedra into bodies that are all of the same size. In this way the metal sets hard again. 'This is called cooling and being compacted.'¹⁰

Freezing is a version of the same process, only applied to the more fluid of the two kinds of water (59D4-E5). The air and fire which are in water are expelled. The water therefore becomes 'more uniform'. It is pressed in upon itself by 'the force of the particles that are departing from it', and it therefore solidifies, it is 'compacted' (παγέν, συμπαγέν), the same word as in the account of metals, this time to form hail and ice, snow and frost.

Now let us turn to Plato's account of the *pathemata*. In the human body (62A5-B6), 'larger sized particles of water', which apparently exist in the air around the body, 'push out' from the body 'the smaller particles', which are presumably particles of fire. The larger sized particles cannot themselves enter the places that are thus vacated because of their size, but they 'press together the moisture that is inside us'. In this way, the body is changed from being in a state of unevenness, or lack of uniformity, and therefore of mobility, to a condition of uniformity and immobility. It freezes therefore and is 'compacted'. We are literally 'frozen stiff'.

Thus the same principles apply to the solidification of metals, to the freezing of water, and to the cooling of the human body. In each case, fire leaves, or is extruded; external pressure therefore forces the body to contract upon itself; the body in question is therefore reduced from unevenness and mobility, to immobility and uniformity. In each case, the result is described as solidification, 'compaction' (πεπηγός, 59A8; παγέν, 59E2; πήγνυσιν, 62B2).

As in the account of heating, the only difference between what happens in the world of the *gene* and what happens in the world of the *pathemata* is that in the latter case the body which is affected is the human body. The way in which it is affected is essentially the same as the way in which water is frozen and metals are solidified.

(iii)

There are four common *pathemata*, if we leave aside for the moment pleasures and pains; these are hot and cold, hard and soft, heavy and

¹⁰ Cornford, *Cosmology* 250.

light, rough and smooth. The explanation of the last pair, Plato tells us, is obvious (63E8-64A1).

In the case of hot and cold and of hard and soft there is clearly a deliberate duplication between Plato's account of the *gene* and his analysis of the *pathemata*.

1. The same principles, the 'cutting action' of fire, the 'solidification' of cold, 'yielding' and 'resistance', occur both in Plato's analysis of the *gene* and in his account of the *pathemata*.

2. Of the terms which Plato uses in his account of the *pathemata*, 'hard' and 'soft' and 'cooling' recur in the account of the *gene*.

It is obviously not a coincidence therefore that heavy and light also appear both in Plato's account of the *gene* and again in his analysis of the *pathemata*. Clearly, the assumption must be that in all three cases the duplication is a deliberate feature of the account which Plato gives of substance and sensation in the structure of the *Timaeus*.

§ 4. SWEET AND SOUR

I take one final instance of duplication, from the particular, as distinct from the common, *pathemata*: Plato's account of sweet and sour, among the *pathemata*, and his account of honey and of *opos*, among the *gene*.

At the beginning of his account of the tastes that we experience, in his analysis of the *pathemata*, Plato states explicitly that what follows is intended to relate directly to, and to complement, the account that he has already given of 'flavours' or 'juices' among the *gene* (χυμοί, 59E5-60B5). Thus immediately after marking the transition from the common to the particular *pathemata* Plato writes, 65C1-3: πρῶτον οὖν ὅσα τῶν χυμῶν πέρι λέγοντες ἐν τοῖς πρόσθεν ἀπελίπομεν, ἴδια ὄντα παθήματα περὶ τὴν γλώτταν, ἐμφανιστέον ἢ δυνατόν.

I paraphrase:

'To start with, then, we must now make clear, so far as we can, the nature of the *pathemata* that are peculiar to the tongue, and in so doing we must return to what we left out in the account which we gave earlier when speaking of juices.'

The coincidence which Plato intends to establish between honey and sweetness will prove to be fairly obvious. The correlation between *opos* and what is sour is less obvious, but I believe no less certain.¹¹

¹¹ It could be objected that 'bitter' and not 'sour' is properly the opposite of 'sweet'; but Plato in fact makes it clear, in a passage quoted immediately below (66B7-C7), that sweetness is opposed to the whole range of tastes described earlier, including both what is 'bitter' (πικρά, 65E1) and what is 'sour' (ὀξύ, 66B7). From this it follows that I have

(i)

In his account of the *gene* that are produced predominantly from water, Plato writes thus of the origin of honey, 60A8-B3: ὅσον δὲ διαχυτικὸν μέχρι φύσεως τῶν περὶ τὸ στόμα συνόδων, ταύτη τῇ δυνάμει γλυκύτητα παρεχόμενον, μέλι τὸ κατὰ πάντων μάλιστα πρόσρημα ἔσχεν.

I paraphrase:

‘The agent which relaxes and restores to their natural state the passages around the mouth, and that by means of this property produces sweetness: this agent has mostly acquired, for all the separate instances of its occurrence, the name of “honey”.’¹²

In this instance, the substance is explained directly in terms of the sensation which it causes. When he comes to the account of the *pathemata*, therefore, Plato has no more to do, in describing sweetness, than to expand the explanation which he has already given, 66B7-C7: σύμψασιν δὲ τοῖς περὶ ταῦτα εἰρημένοις πάθος ἐναντίον ἀπ’ ἐναντίας ἐστὶ προφάσεως· ὁπόταν ἢ τῶν εἰσιόντων σύστασις ἐν ὑγροῖς, οἰκεία τῇ τῆς γλώττης ἔξει πεφυκυῖα, λεαίνῃ μὲν ἐπαλείφουσα τὰ τραχυθέντα, τὰ δὲ παρὰ φύσιν συνεστῶτα ἢ κεχυμένα τὰ μὲν συνάγῃ, τὰ δὲ χαλᾷ, καὶ πάνθ’ ὅτι μάλιστα ἰδρύη κατὰ φύσιν, ἡδὺ καὶ προσφιλὲς παντὶ πᾶν τὸ τοιοῦτον ἴαμα τῶν βιαίων παθημάτων γιγνόμενον κέκληται γλυκύ.

I paraphrase:

‘The effect which is opposite to the whole series of circumstances that have been described (*sc.* for the production of other tastes) springs from an opposite cause and condition.

‘When the structure of the particles that enter the body contained in some watery substance is of a nature that is akin to and that harmonises with the condition of the tongue, then such a substance smooths and caresses whatever parts of the tongue have been roughened. It closes together whatever has fallen apart. It opens up whatever has become too tightly constricted. It restores everything, as far as may be, to its natural and proper state.

‘The intervention of such healing and curing of violent and unnatural affections is invariably pleasing and welcome: and the name which such an action has is “sweet”.’

slightly adapted Plato’s arrangement to my own purposes, in singling out sweet and sour as a pair, comparable to hot and cold and hard and soft, when for Plato they are not strictly opposites in the same exclusive sense.

The main divisions of taste which Plato opposes to sweetness, ‘astringent’ (στρυφνά, 65C6-D4), ‘bitter’ (πικρά, 65D4-E4), ‘pungent’ (δριμέα, 65E4-66A2) and ‘sour’ (ὀξύ, 66A2-B7), are best paralleled and exemplified in the concluding chapter of the pseudo-Aristotelean treatise, *De plantis*, which describes various processes affecting fruit, ii 10, 829a36-830b4.

¹² I translate μέλι as ‘honey’, though Plato has in mind a wider range of substances than we usually include under that word—hence ‘for all the separate instances of its occurrence’ (τὸ κατὰ πάντων): cf. below p. 118. An alternative rendering would be ‘syrup’.

Honey, it is true, is 'divisive' of 'the passages around the mouth' (διαχυτικόν), whereas what is sweet has the double action of 'opening up' certain parts of the tongue (χαλᾶ), and of 'bringing together' others (συνάγει).

This slight discrepancy, between 'dividing' and 'bringing together', is the result of sweetness being offered as an antidote to the effects both of what is 'astringent' (στρυφνά, αὐστηρά, 65C6-D4), and of what is 'bitter' (πικρά, 65D4-E1).

1. The agent which is astringent 'constricts' the little veins leading from the tongue (συνάγει, 65D2).
2. What is bitter 'washes out' the little veins (ἀποπλύνοντα, 65D5), and in so doing leaves them eroded and exposed (this I take to be the connotation of ἀποτήχειν, 65D7).

Sweetness must therefore 'open up' the passages which have been 'constricted' in the *first* instance, and 'close up' the passages that have been 'washed open' and left exposed in the *second* instance.

But this double action of sweetness is incidental to the main purport of the two passages describing honey (60A8-B3) and describing what is sweet (66B7-C7). In either case, honey and sweetness restore the passages of the tongue, or the mouth, to their 'natural' state (cf. μέχρι φύσεως, 60B1; κατὰ φύσιν, 66C5). The effect produced by honey, among the *gene*, is the same therefore as that of sweetness, as analysed among the *pathemata* (γλυκύτητα, 60B2; γλυκύ, 66C7).

(ii)

In his account of the *gene*, immediately after the description of honey, Plato writes as follows, 60B3-5: τὸ δὲ τῆς σαρκὸς διαλυτικὸν τῷ κάειν, ἀφρώδες γένος, ἐκ πάντων ἀφορισθὲν τῶν χυμῶν, ὁπὸς ἐπωνομάσθη.

Cornford translates: '... a frothy substance distinct (?) from all the other juices.'¹³ Cornford's question is, I think, answered, if we turn to the corresponding passage in the account of the *pathemata*: the analysis of sourness that immediately precedes the account of sweetness.

Plato there writes that sourness is produced from substances that 'have been broken down into thin pieces by rotting' and that by an elaborate process produce 'bubbling and fermentation' (66A2-B7). His account begins, 66A2-3: τὰ δ' αὖ τῶν προλελεπτυσμένων μὲν ὑπὸ σηπεδόνος ...¹⁴ The 'bubbling and fermentation' in the account which Plato gives of sourness among the *pathemata* is intended to correspond, I suggest, to the descrip-

¹³ *Cosmology* 254.

¹⁴ The whole passage is transcribed almost immediately below, pp. 118-19.

tion which had been given earlier of *opos* as 'a kind of frothy stuff' (ἀφρώδες γένος, 60B4), when Plato was writing of the *gene*. If that is so, then ἀφορισθέν, in the description of *opos*, will mean not 'conceptually distinct', as Cornford supposes, but literally 'separated off'. *Opos* is 'a secretion from all other juices', when they have been left to rot and as we say 'go sour'.

This explanation of *opos* will, I think, serve to answer Cornford's objection: 'It seems manifestly untrue that a juice bitter enough to burn the tongue is *secreted* from all the other juices—honey, for instance.'¹⁵

1. As Cornford himself had rightly noted, 'honey' (μέλι) is used for several different kinds of secretion from plants and trees.¹⁶ Plato might well have supposed that some of these would 'rot' and 'go sour'.

2. Even honey taken from bees was fermented and turned into wine, or so it was believed.¹⁷ Fermentation is precisely the process described in Plato's account of sourness.

On either ground, or on both grounds, therefore, Plato may, I think, have supposed that there could be produced an acidic secretion from honey, as from the other 'kinds of water' that are 'strained through plants from the earth' (59E5-60A1).

I translate therefore, 60B3-5:

'What dissolves flesh by burning, a kind of frothy stuff, a secretion formed from all juices, is called "*opos*".'

(iii)

In the later passage, in the account of the 'bubbling' or 'frothing and fermentation' that accompanies, or that causes, the taste of sourness, among the *pathemata*, Cornford is again at a loss.

Plato writes, 66A2-B7: τὰ δ' αὖ τῶν προλελεπτυσμένων μὲν ὑπὸ σπινθῆρος, εἰς δὲ τὰς στενὰς φλέβας ἐνδυσόμενων, καὶ τοῖς ἐνοῦσιν αὐτόθι μέρεσιν γεώδεσιν καὶ ὅσα ἀέρος συμμετρίαν ἔχοντα, ὥστε κινήσαντα περὶ ἄλληλα ποιεῖν κυκᾶσθαι, κυκώμενα δὲ περιπίπτειν τε καὶ εἰς ἕτερα ἐνδυσόμενα ἕτερα κοῖλα ἀπεργάζεσθαι περιτεινόμενα τοῖς εἰσιούσιν — ἃ δὲ νοτίδος περὶ ἀέρα κοίλης περιταθείσης, τοτὲ μὲν γεώδους, τοτὲ δὲ καὶ καθαράς, νοτερὰ ἀγγεῖα ἀέρος, ὕδατα κοῖλα περιφερῇ τε γενέσθαι, καὶ τὰ μὲν τῆς καθαράς διαφανεῖς περιστῆναι κληθείσας ὄνομα πομφόλυγας, τὰ δὲ τῆς γεώδους ὁμοῦ κινουμένης τε καὶ

¹⁵ *Cosmology* 254 n. 7.

¹⁶ *Cosmology* 254 n. 6. The longest list is that given in [Arist.] *De mirabilibus auscultationibus* 16-22, 831b18-832a13. For some other references see LSJ, s.v.

¹⁷ *De mir. ausc.* 22, 832a5-13.

αίρομένης ζέσιν τε καὶ ζύμωσιν ἐπικλὴν λεχθῆναι — τὸ δὲ τούτων αἴτιον τῶν παθημάτων ὁξὺ προσρηθῆναι.

For Cornford, 'the construction and meaning are here uncertain.'¹⁸ In fact, either passage helps to explain the other. Plato's intentions will be reasonably clear, if we take the account of *opos* among the *gene* (60B3-5), and the account of sourness among the *pathemata* (66A2-B7), to be describing a similar, or the same, phenomenon.

1. The fact that *opos* is 'separated off' or 'secreted from all the juices' (60B3-5) is explained by the fact that sourness arises 'from things that have been broken down into small pieces by rotting' (66A2-3).

2. The 'bubbling' or 'frothing and fermentation' in the second passage (esp. 66B1-6) is simply a more elaborate account of what has earlier been described as a 'frothy stuff' (ἀφρώδες γένος, 60B4), in the same way that the account of sweetness as a *pathema* (66B7-C7) is simply a more elaborate account of the description given of honey in the course of Plato's analysis of the *gene* (60A8-B3).

If we adopt these two poles of reference, as it were, the 'rotting substances' at the beginning of the passage, and the 'frothing and fermentation' at the end of the passage, as both alike being descriptions of the origins, and of the effect, of *opos*, then the centre of the passage, which is otherwise impossibly tortuous, becomes reasonably clear.

Κυκᾶσθαι (A6), Cornford rightly notes, 'is important'. Theophrastus 'summarises the entire sentence in τὰ δὲ κυκῶντα ὁξέα'. But at the same time, for Cornford, this expression 'is ambiguous'.¹⁹

Περιπίπτειν, immediately following, Cornford explains, with obvious hesitation, as 'a possible passive of περιβάλλειν', and he translates therefore 'to form an enclosure.'²⁰ However, taken in this way, περιπίπτειν means in effect the same as the clause which follows next but one: the particles 'produce hollow films', κοῖλα ἀπεργάζεσθαι περιτεινόμενα τοῖς εἰσιούσιν (A7). This makes Cornford's interpretation doubly unsatisfactory. The meaning he proposes for περιπίπτειν is dubious in itself. In this context, it simply repeats what Plato says—more clearly—two clauses later.

The interpretation I would suggest is that περιπίπτειν (1) takes its connotation from κυκᾶσθαι, and (2) explains the clause immediately following: εἰς ἕτερα ἐνδύόμενα ἕτερα (A6-7).

¹⁸ *Cosmology* 271 n. 3.

¹⁹ Cornford, *Cosmology* 271 n. 3. Theophrastus, *De sens.* 84.

²⁰ *Cosmology* 271 n. 3.

1. When the particles are ‘stirred up’ (κυκώμενα) and ‘made to follow each other round and round’ (cf. κινήσαντα περὶ ἀλλήλα), they ‘fall upon one another’ or even ‘tumble over one another’ (περιπίπτειν).

2. In this way, they are made to press upon one another, and for this reason ‘each kind of particle finds its way inside the others’ (εἰς ἕτερα ἐνδύόμενα ἕτερα).

The result of this activity I take to be the thickening which we may expect to result from ‘churning’, the translation which Cornford happily provides of κυκᾶσθαι.²¹ Because particles of one kind work their way inside other kinds of particles, what had been a fluid substance is able to form skins, or films. These skins are formed either from clear water, or from water mixed with earth. In either case they form bubbles of air. The earthy bubbles rise to the surface, where they appear as ‘frothing and fermentation’, the feature which links the account of sourness to the account of *opos*.

The sense of περιπίπτειν therefore I take to be essentially no different from its most common meaning of ‘meeting’ or ‘falling in with someone’, but perhaps with the more particular connotation which appears in Herodotus, where the Persian ships are ‘in confusion’ and ‘fall foul of’ or ‘become entangled with’ one another, viii 16: ... ταρσσομένων τε τῶν νεῶν καὶ περιπιπτουσέων περὶ ἀλλήλας. In Plato’s elaborate but also highly abbreviated sentences, I think that περὶ ἀλλήλα can easily be understood, or perhaps one should simply say is taken for granted, from περὶ ἀλλήλα and εἰς ἕτερα ... ἕτερα in the clauses immediately preceding and following (A5 and A6-7).

There remains only the question: why some bubbles should rise, and in particular why only the earthy ones should do so. Again, I suggest, the answer is supplied by Plato’s earlier account of *opos*. All juices, Plato tells us, are made of water, and most of them are without names. The four which Plato chooses to describe are all specifically said to be ‘fiery kinds of water’, 60A3: ἔμπυρα εἶδη. This must explain why all these juices are ‘transparent’ (διαφανῇ μάλιστα), and in particular why wine ‘warms soul and body’, why oil ‘cuts into the visual ray and is bright and shiny’, and why *opos* ‘dissolves the flesh by burning it’ (60A3-8).

This feature of *opos* is overtly repeated in Plato’s account not of what is ‘sour’ (ὀξύ), but of things that are ‘pungent’ (δριμέα). For things pungent ‘join with the heat in the mouth’ and ‘rise to the senses of the head because of their lightness’; in doing so, they ‘cut whatever they fall upon’ (65E4-66A2). But I suspect that fire is also intended to be present in

²¹ *Cosmology* 271.

Plato's account of what is 'sour'. Plato does not say so directly. But he does say that the elements which 'the particles produced from rotting' encounter in our veins are air and earth. The implication, I think, is that the particles which enter are made from the other two elements, fire and water, which had been specified (59E5-60B5) as constituting the four 'juices', including *opos*.

As the 'demiurge of unevenness' and therefore of movement, which is how Plato describes fire in the account of metals (59A5), this fire will then be responsible for the initial movement and 'churning' of the particles of earth and air.

The bubbles which are then formed are of two kinds: 'clear' bubbles (*διαφανεῖς*), and earthy bubbles which rise to the surface. In these two kinds of bubbles, I suspect that we are intended to see repeated the two effects which Plato had earlier attributed to fire.

1. Precisely in the way that all the 'fiery kinds' of juices are said to be 'transparent' (*διαφανῆ*, 60A4), so now the bubbles of 'clear water' are said to be transparent (66B3).

2. Precisely as in the account of pungent things, which 'rise to the head because of lightness' (65E6-7), so now fire causes the earthy bubbles to rise (66B4-5).

I paraphrase therefore (66A2-B7):

The originating particles

'The requisite particles are formed from things that have already been rendered down to a fine texture by a process of rotting, and that are therefore enabled to work their way into the narrow veins of the body.

The first effect: circular movement

'These particles are a match both for the earth-like particles that have their place within the veins, and also for the particles that are made of air, in such a way that they are able to make the particles of earth and air move round and round after one another, and so are able to produce a stirring movement.

The second effect: thickening

'The particles that are thus being stirred are made to tumble upon one another, and thus particles of one kind work their way in between particles of another kind.

'As they do so, the earth and the air are made to form hollow enclosures, wrapped all around by the incoming particles.

The final effect: bubbling

'In this way it comes about that hollow moisture is stretched around air. Sometimes it is earthy in composition. Other times, the moisture is clear.

'When this happens, there are formed moist bags of air: droplets of water, hollow and round.

Conclusion: nomenclature

'The ones that are made of clear water form transparent enclosures, and are called by the name of "bubbles".'

'The ones that include earth rise to the surface at the same time as they are being set in motion, and produce what is called "frothing" and "fermentation".'

'The cause of either effect goes by the name of "sour".'²²

(iv)

If this interpretation is accepted, then we have a further striking instance of the parallelism between *gene* and *pathemata*.

1. *Opos*, the acidic substance produced from fruit or juices that have been left to 'go sour', produces 'froth'.

2. The same 'bubbling' or 'frothing and fermentation' is produced by such a substance inside our own bodies, and gives us a sour or an acid taste.

Once again, the *pathema* is simply the effect, within the human organism, of precisely the processes that are held to be at work in the world at large.

Clearly, therefore, Plato's purpose is to establish a direct correlation between the *gene* and the *pathemata*, between the primary particles or the substances formed from them, and the effect which these same substances produce in, or upon, the human body.

²² I do not hope to have solved all the problems in what is perhaps the most difficult sentence, grammatically, in the whole of the *Timaeus*. The manuscripts at 66A2 have τῶν δὲ αὐτῶν προλελεπτυσμένων. Cornford, *Cosmology* 271, adopts the reading τὰ δὲ αὐτῶν ..., which I have also done, simply because it matches the way in which Plato has introduced his account of flavours 'bitter' (τὰ δέ, 65D4) and 'pungent' (τὰ δέ, E4). Taylor, *Commentary* 467, adopts the text in Burnet, τὸ δὲ αὐτῶν ..., which he explains as τὰ προλελεπτυσμένα, so that the meaning is virtually the same. In the lines following, I take the three infinitives, κυκᾶσθαι, περιπίπτειν and ἀπεργάζεσθαι (66A5-7), to depend upon ποιεῖν, although the sense is not much different if the latter two infinitives are taken to depend directly on ὥστε. It is purely for the convenience of the English that I have preferred to adopt a passive construction. In the expression περιτεινόμενα τοῖς εἰσιούσιν (66A7), Cornford, *Cosmology* 271 n. 3, takes the meaning to be that particles of air pass 'inside' the bubbles that are formed around them. But it seems to me much more natural to suppose that τοῖς ἐνοῦσιν (66A4) and τοῖς εἰσιούσιν (A7) are contrasted as respectively the particles which are already inside the body (earth and air) and the particles which enter the body from without (fire and water, on my interpretation). The meaning I take to be that the particles of earth and air that were originally within the body are surrounded by the incoming particles of what I suppose to be fire and water: it is in this sense that a spear is 'covered by a skin' or that seeds are 'fitted tightly within a pod', cf. LSJ, s.v. περιτείνω. The infinitives within the relative clause (66B1-6) are puzzling: Taylor, *Commentary* 468-9, takes them to depend, irregularly, on ὥστε (A5).

Hard and soft

1. Earth and metals are hard either because they are densely packed or because their surfaces are stable and resistant. So too we feel as hard whatever is resistant to our flesh.

2. Water is soft because it 'yields' to earth or stone. So too we feel as soft whatever 'yields' to our flesh.

Hot and cold

1. Fire cuts up other elements by the sharpness of its angles and its edges. It acts upon our body in precisely the same way when we feel heat.

2. Our growing stiff with cold is effected by the same processes, the withdrawal of fire, contraction and solidification, as the cooling and solidifying of metals, and the freezing of water into ice or snow.

Sweet and sour

1. Honey restores the passages in our mouth to their natural state, and thereby gives us the taste of sweetness.

2. Sourness or bitterness is caused by an acidic secretion which sets up in us the same process of frothing and fermentation which we can see produced by it in the juices from which it is secreted.²³

²³ The parallel passages are as follows, in the order in which they appear in the text of the *Timaeus*. (1) 'Hot' and 'cold' among the *gene*: the cutting action of fire in the transformation of the elements, 56E8-57A2, cf. 56A5; the cooling and solidification of metals, 59A1-8; the freezing of water to form hail and ice, snow and frost, 59D4-E5. (2) 'Hard' and 'soft' among the *gene*: adamant, 59B5; copper, 59B6-C3; water and earth or stones, 59D4-7. (3) 'Sweet' and 'sour' among the *gene*: honey, 60A8-B3; *opos*, 60B3-5. (1) 'Hot' and 'cold' among the *pathemata*: 61D5-62A5 (hot), 62A5-B6 (cold). (2) 'Hard' and 'soft' among the *pathemata*: 62B6-C3. (3) 'Sweet' and 'sour' among the *pathemata*: 66A2-B7 (sour); 66B7-C7 (sweet).

CHAPTER SEVEN

THE NATURE OF 'PATHEMATATA'

§ 1. MISINTERPRETATIONS OF 'PATHEMATATA'

Before turning to consider directly whether, or how far, this same duplication may explain the two theories of weight, as defined by number and density, and as defined by direction and by resistance, we need to consider more precisely what Plato means by the term I have so far transliterated as *pathema*.

Two opposite interpretations have been adopted of this term hitherto. According to Taylor, fire would be 'hot' even if we had no direct sensation of heat, and could only infer that fire was hot in the way, supposedly, that we infer that an iron bar is magnetised. The *pathemata* or the *pathe* therefore, Taylor tells us, are 'characters of the various bodies themselves', and not 'effects produced by the bodies on a percipient'.¹ Cornford replies that if the *Timaeus* is to be consistent with the theory of sensation outlined in the *Theaetetus* then an object can be white or hot only if, and for so long as, we perceive it to be so. The *pathemata* in question are therefore 'distinguished' by Plato 'from those properties which bodies are supposed to possess in the absence of any sentient being, such as the shapes of the microscopic particles, which are never perceived'.²

Both interpretations, it seems to me, contain elements of confusion. In particular, they render virtually insoluble the problem of the two theories of weight.³

(i)

Rather oddly, Taylor ignores Plato's earlier theory, where there is no mention of a percipient, and where therefore his interpretation might seem to have been most at home, and he concentrates instead on Plato's later theory, of weight as defined by resistance, which he takes to be an anticipation of modern theories of gravitation.

¹ *Commentary*, esp. 431-2.

² *Cosmology*, esp. 259ff. Cf. Francis M. Cornford, *Plato's theory of knowledge, the 'Theaetetus' and the 'Sophist' of Plato translated with a running commentary* (London and New York, 1935), esp. 45-51.

³ Some ambiguities in Taylor's and in Cornford's understanding of *pathemata* are reviewed in Note 7, where I also take some account of other interpretations, notably that of Martin. See pp. 369-79 below.

Thus Taylor tells us that, although Plato lacks any proper conception of mass, his theory is 'really in the true line of thought which ultimately leads to our modern notions about gravitation'.⁴ The idea seems to be, although it is not stated explicitly, that weight, for Plato, is determined by the 'force' with which a body travels to its like, and that this is akin to the 'force' of gravitation. From this point of view, therefore, the human observer is introduced solely for the purposes of illustration.

Weight—like every other *pathema*—thus becomes 'the character of the body itself', while the undeniable 'effect' which in this case is 'produced on a percipient' is rendered incidental to the theory.

(ii)

Cornford does not ignore the earlier theory, as Taylor has done; but he no less effectively reduces the earlier theory to the later.

Thus in a note to the theory of weight as defined by number Cornford refers to the later theory of weight as defined by resistance, and writes:

'It will be easier to force a fire pyramid in among the octahedra of air, than to force an octahedron in among the pyramids.'⁵

But this is inaccurate on two counts. In his account of weight among the *gene*, Plato makes no reference to the action of the observer, or of the percipient, whose presence is implied in Cornford's formula. And if we do agree to introduce the later theory at this point, we should not overlook that in the account of weight as defined by resistance, there will be no comparison between *different* elements, as there is here between air and fire in Cornford's formula. The only overt comparison which Plato makes in his account of weight as defined by resistance lies between different quantities of the *same* element.

Moreover, if we do apply Cornford's principle to the comparison, in the later theory, between a larger and a smaller quantity of fire, then the result would appear to be the opposite of the answer which Plato's own statement of his theory would require. For since there will be more cutting edges in a larger than in a smaller quantity of fire, then the larger quantity would presumably be easier to 'force ... in among the octahedra of air'; and the larger quantity would therefore presumably be lighter, contrary to Plato's assertion that it is the smaller quantity which is easier to move away from its parent element, and which is lighter therefore.

Clearly, this part of Cornford's reconstruction cannot be what Plato intended.⁶

⁴ *Commentary* 441-3, cf. 434-6.

⁵ *Cosmology* 222 n. 4.

⁶ Cornford is also in error in seeking to introduce the resistance of the medium; there is no mention of this idea in either theory. On this point see further Note 7 below, esp. pp. 375-6.

(iii)

It is true, Cornford does himself compare different quantities of the same element when at the beginning of the same note he remarks that:

‘Water composed of large particles is harder to move and *heavy*.’⁷

The comparison implied here is between two forms of water, the more fluid and the less fluid kind. But in fact, in the passage in question, Plato tells us not that water is ‘harder to move’, but that it is ‘more inclined to be stationary’, 58E1: *στασιμώτερον*. It may seem quibbling to make this distinction, but in fact we can tell quite precisely what it is that Plato means by this term.

For the meaning of *στασιμώτερον*, in this context, is sufficiently shown, *per contrariam*, by the description immediately before this of the kind of water which is made from small particles and which is therefore ‘more mobile, both in itself and when affected from outside’, 58D7: *κινητικὸν αὐτὸ τε καθ’ αὐτὸ καὶ ὑπ’ ἄλλου*. The heavier kind of water, we may infer, will likewise be ‘the more stable’, both when left to its own devices (*αὐτὸ καθ’ αὐτό*), and when subjected to disturbance from without (*ὑπ’ ἄλλου*). The outside agency which Plato introduces explicitly is fire: ‘heavy’ water shows its stability, and its loss of stability, in the processes of melting and solidification, which are caused in large part by the entry and withdrawal of fire (58E2-59A8).

Thus in the context of Plato’s analysis it is already special pleading to translate *στασιμώτερον* as ‘harder to move’, and certainly it is erroneous then to transfer the description to the account of weight as defined by resistance. *Στασιμώτερον* refers to an outside agency, only in part. The outside agency which Plato has in mind is clearly fire; there is no indication of water being moved, or being ‘hard to move’, by a human, or by a sentient, agent. And finally, there is no question, at this stage, of water being ‘harder to move’ out of its own region and into the region of another element, which would be the minimal meaning required to make this sense of ‘heavy’ conform to the analysis of weight in terms of resistance.

It is true that ‘more stable’ and ‘heavy’ in the account of water are the obvious counterpart to ‘most mobile’ and ‘lightest’ in Plato’s description of fire (*εὐκίνητότατον*, *ελαφρότατον*, 56A6-B2). The repetition makes it clear that weight and mobility are connected therefore, if only in that they are both the product of number or size: fire is ‘lightest’ and at the same time ‘most mobile’ because the tetrahedron has the smallest

⁷ *Cosmology* 222 n. 4.

number of surfaces; water which is made from large particles is 'heavy' and at the same time 'the more sedentary'.

But we have no right to infer from this that the 'most mobile' element is therefore the easiest to dislodge from its parent body, while the 'more sedentary' element is therefore harder to move into a region other than its own. Nor even if we could do so would we have arrived at a conclusion necessarily consistent with the later theory, of weight as defined by resistance. For Plato's theory of weight as measured by resistance tells us only that it is more difficult to dislodge a larger portion of *either* element from its native body; in Plato's account of weight as measured by resistance, no comparison is made between different elements, nor even is there any explicit comparison between different grades of the same element.⁸

(iv)

The truth is that Cornford's assumptions about weight, no less than those of Taylor, stem from the interpretation which either scholar has adopted of the nature of the *pathemata*, whether as 'characters of the bodies themselves', or as properties dependent upon the co-operation of a percipient.

1. In order to make heavy and light conform to his interpretation of the *pathemata*, Taylor seeks to minimise the role of the human observer in the theory of weight as measured by resistance, so that he can reduce heavy and light to the status of 'characters of the bodies themselves'.

2. Equally, in order to make heavy and light support his interpretation of the *pathemata*, Cornford seeks to expand the theory of weight as defined by number into a theory of resistance as determined by shape, so that in both Plato's theories of weight heavy and light can be seen as properties dependent upon the co-operation of a percipient.

It is to these two interpretations of the *pathemata* that we must turn our attention therefore.

⁸ I hope that I am not overstating my case against Cornford. In my own attempt to reconcile the two theories, I shall maintain that in the later theory, where weight is defined by resistance, we are given no means for comparing different elements, and that this comparison therefore remains peculiar to the earlier theory, of weight as defined by number. On the other hand, I shall argue that the movement of the elements, in the sense of their distribution each to its own place within the cosmos, does have an essential part to play in the conciliation of the two theories. See further ch. VIII § 3, pp. 153-7 below, and *cf.* ch. XIII § 5, pp. 259-66 below.

Not until Plato's conception of the *pathemata* has been accurately diagnosed, can we hope to disentangle the true relation between Plato's 'two' theories of heavy and light.

§ 2. TAYLOR'S 'PATHEMATA'

(i)

Taylor claims that the *pathemata*, as 'characters of the various bodies themselves', are distinct from 'effects produced by the bodies on a percipient'.⁹ This claim founders on Plato's repeated qualification (from 61C3 to 68D7) that the *pathemata* have to do with the human body, whether with the human body taken as a whole, or at least no more narrowly specified than as 'flesh', or with 'individual parts' of the body.

1. Plato tells us to look at the cutting action of fire 'as it takes place in relation to our body', 61D7: *περὶ τὸ σῶμα ἡμῶν γιγνομένην*.

2. Cold is caused by the action 'of the moist elements that surround our body', 62A6-7: *τῶν περὶ τὸ σῶμα ὑγρῶν*.

3. Things are hard 'if our flesh yields to them', and soft 'if they yield to our flesh', 62B6-7: *ὅσοις ἂν ἡμῶν ἡ σὰρξ ὑπείχῃ* and *ὅσα ἂν τῇ σαρκί*.

4. The cause of pleasures and pains is the last and the greatest of 'the *pathemata* that are common to the whole body', 64A2-3: *τῶν κοινῶν περὶ ὅλον τὸ σῶμα παθημάτων*.

5. Pleasures and pains will also accompany 'whatever *pathemata* achieve sensation through the parts of the body', 64A4-5: *καὶ ὅσα διὰ τῶν τοῦ σώματος μορίων αἰσθήσεις κεκτημένα*.

6. Flavours are '*pathemata* peculiar to the tongue', 65C2-3: *ἴδια ... παθήματα περὶ τὴν γλῶτταν*.

7. Smell is 'a power that resides in our nostrils', 66D1-2: *περὶ δὲ δὴ τὴν τῶν μυκτῆρων δύναμιν* ...

8. The *pathemata* of hearing are explained by a 'blow' inflicted on the brain and blood and setting up a motion which reaches to the liver (67A7-C3).

9. 'Vision' is at this stage in the treatise mainly devoted to a catalogue of colours (67C4-68D7); but also included is an account of how tears are formed from the fire and water that are found in the passages of the eyes (67E6-68B1).

This string of references, throughout Plato's account of the *pathemata*, to the percipient, and more narrowly to the body of the percipient, whether to the whole body or to parts of it, cannot be coincidental. At the very least, Plato's intention must be to include among the *pathemata* not only the 'characters of the various bodies themselves', but also, in some way, the 'effects produced by the bodies on a percipient'.

⁹ *Commentary* 431-2; cf. pp. 124-5 above.

(ii)

Plato's intention is again sufficiently obvious when he concludes his account of the extrusion of particles of fire and the consequent compaction of the body, by writing that the body naturally resists being forced in upon itself, and that the fight which follows results in 'shaking and shivering.' 'This whole *pathos*,' Plato concludes, 'and the agent which causes it have the name "cold"', 62B2-6: ... τῇ δὴ μάχῃ καὶ τῷ σεισμῷ τούτῳ τρόμος καὶ ῥίγος ἐτέθη, ψυχρόν τε τὸ πάθος ἅπαν τοῦτο καὶ τὸ δρῶν αὐτὸ ἔσχεν ὄνομα.

It is sufficiently obvious that the distinction which Plato intends here between the *pathos* and the agent is not, as Taylor's analysis would require it to be, a distinction between an external object and the character or property which resides within such an object. Plato is talking about the effect that cold has upon us: 'shaking and shivering'. The point must be that the name 'cold' applies both to our feeling, *pathos*, 'I feel cold', and to the object which causes our feeling, 'the wind is cold', 'the water is cold'.

When he comes to this passage, Taylor has in fact to admit as much. He writes:

'The *πάθος* of the body subjected to the process is called *ψυχρόν*, and the same name is given to the foreign body which induces such a state.'¹⁰

But this is inconsistent with Taylor's earlier declaration that the *pathe* or *pathemata* are 'characters of the various bodies themselves', and *not* 'effects produced by the bodies on a percipient'.¹¹

But Taylor cannot afford such inconsistency. For the distinction which Plato draws in the case of cold is not an isolated occurrence. Plato later repeats precisely this distinction, between the *pathos* and the agent which causes the *pathos*, as applying to all the common *pathemata*. Thus at the point at which he makes the transition from the common to the particular *pathemata*, Plato tells us that he has now considered 'the common *pathemata*, and at the same time the names that attach to the agents that produce these *pathemata*', 65B4-7: καὶ τὰ μὲν δὴ κοινὰ τοῦ σώματος παντὸς παθήματα, τῶν τ' ἐπωνυμιῶν ὅσαι τοῖς δρῶσιν αὐτὰ γεγονόνασι, σχεδὸν εἴρηται.

In this same passage, Plato announces his intention of applying this same distinction to the particular *pathemata*. 'We must try to explain, if

¹⁰ *Commentary* 432.

¹¹ *Commentary* 431, cf. pp. 124-5 above. In the expression τὸ δρῶν αὐτό, 62B6, quoted above, Taylor, *Commentary* 432, claims that αὐτό is nominative, not accusative, and translates 'the agent itself'. This gives a nice fillip to Taylor's objectivist interpretation of Plato's theory. But the translation is wrong. When Plato makes exactly the same point of all the common *pathemata*, there is no ambiguity; he writes, 65B5, quoted immediately below, τοῖς δρῶσιν αὐτά.

we are able, what comes to pass in the particular parts of our bodies, both the *pathe* and how they are caused by the agents that produce them', 65B6-C1: τὰ δ' ἐν ἰδίῳις μέρεσιν ἡμῶν γιγνόμενα, τὰ τε πάθη καὶ τὰς αἰτίας αὐτῶν δρῶντων, πειρατέον εἰπεῖν, ἅν πη δυνώμεθα.

Evidently Plato's intention, throughout his account both of the common and of the particular *pathemata*, is to describe, in some way, *both* the 'feelings', *pathemata*, which we have in our bodies, *and* the agents which arouse these feelings in us.

(iii)

From this point onwards (65C1), where Plato is dealing with the specialised perceptions of taste, of smell, of hearing and of vision, it is in fact impossible for Taylor to maintain that the *pathemata* are 'characters of the bodies themselves' and not 'effects produced by the bodies on a percipient'. He therefore argues that at this point Plato turns to consider the subject which he had earlier distinguished from the *pathemata*, and which he had said he would postpone until after his account of the *pathemata*.¹² But this leads to fresh complications.

The 'postponement' follows the list of secondary substances formed from the four main cosmic elements or *gene* (58C5-61C4) and precedes the analysis of the common *pathemata* (61D5ff.). In the intervening passage, Plato writes as follows, 61C4-D5: τὰ δὲ παθήματα αὐτῶν (*sc.* τῶν εἰδῶν) δι' ἃς αἰτίας γέγονεν πειρατέον ἐμφανίζειν· πρῶτον μὲν οὖν ὑπάρχειν αἴσθησιν δεῖ τοῖς λεγομένοις αἰεῖ, σαρκὸς δὲ καὶ τῶν περὶ σάρκα γένεσιν, ψυχῆς τε ὅσον θνητόν, οὕτω διεληλύθαμεν· τυγχάνει δὲ οὔτε ταῦτα χωρὶς τῶν περὶ τὰ παθήματα ὅσα αἰσθητικὰ οὐτ' ἐκεῖνα ἄνευ τούτων δυνατὰ ἱκανῶς λεχθῆναι, τὸ δὲ ἅμα σχεδὸν οὐ δυνατόν· ὑποθετέον δὲ πρότερον θάτερα, τὰ δ' ὑποτεθέντα ἐπάνιμεν αὐθις· ἵνα οὖν ἐξῆς τὰ παθήματα λέγῃται τοῖς γένεσιν, ἔστω πρότερα ἡμῖν τὰ περὶ σῶμα καὶ ψυχὴν ὄντα.

I paraphrase:

'We have now to try to make clear how the *pathemata* which belong to the *eide* have come to be as they are.

'But first let me explain (πρῶτον μὲν οὖν ...): sensation must underlie at every point what it is that we are <now> saying, and yet so far we have not been through the origins of flesh, and of things to do with flesh, nor have we described the mortal part of soul.

'This then is how things stand (τυγχάνει δέ ...): flesh and soul cannot be adequately spoken of without the *pathemata* that have to do with sensation, and these *pathemata* cannot adequately be spoken of in isolation from flesh and soul, while to speak of both at once is hardly possible.

¹² *Commentary* 464, quoted immediately below.

'We must start then by taking for granted one or other subject, and the subject we have taken for granted we shall have to come back to later.

'So in order to have the account of the *pathemata* follow directly our account of the *gene*, let what has to do with body and soul be the subject that is first taken for granted.'

The sequence of thought here is essential. There are two subjects, one or other of which Plato must postpone: (1) the *pathemata*, and (2) 'the origin of flesh and of things associated with flesh', and 'the mortal part of soul'.

Plato's point is not quite so simple as that either subject would directly 'presuppose' the other. The point is rather that sensation is implicated in the exposition of either subject, and it is for this reason that the exposition of either one subject will involve reference to the other.

1. Talk of the *pathemata* involves talk of sensation, and talk of sensation involves talk of 'flesh and things associated with flesh' and of 'the mortal part of soul'.

2. But the reverse is also true: an account of mortal soul, and of flesh and things associated with flesh, would require an account of sensation and therefore an account of the *pathemata*.

Hence Plato's dilemma: he cannot give an account of either subject without reference to the other, and he cannot talk of both subjects at once.

Plato decides to deal first with the *pathemata*, since this follows naturally upon his account of the *gene*, and to postpone his account of 'the origin of flesh and of things associated with flesh' and of 'the mortal part of soul'.

So much should be clear, and even obvious. Taylor however attempts to make the distinction between the first and second subject fall between the account of the common and the particular *pathemata*. His attempt to do so is a striking lesson in just how far critical and ideological presuppositions can blind their victim to the meaning of the actual words which he finds on the page before him.

Thus on the passage where Plato describes the transition from the common to the particular *pathemata* (65B4ff.), Taylor writes as follows:

'Timaeus now goes back to take up the subject which had been postponed at 61D4', the passage I have quoted, where Plato first introduces the account of *pathemata*. 'He said there that he would for the time being "postulate" our possession of sense-organs, and would talk of the properties of body they enable us to perceive, postponing the account of the structure and working of the organs themselves.'¹³

¹³ *Commentary* 464.

But Plato had not said that he would ‘postulate’ our possession of ‘sense-organs’. It is a dangerous confusion of ideas to paraphrase ‘flesh, and things connected with flesh, and the mortal part of soul’ as ‘sense-organs’ and their ‘structure and working’. I suspect, in fact, that Taylor has loosely conflated Plato’s allusion to *aisthesis* with his mention of flesh, and that Taylor’s talk of ‘sense-organs’ springs from his conflation of these two ideas, with the advantage, for Taylor’s general thesis, that Plato’s account of the particular *pathemata* (65B6ff.) can then be construed as an account of sense-organs, while the common *pathemata* (61D5ff.) Taylor can then hope to restrict to ‘the properties of body they enable us to perceive’.

Instead, I take Plato’s point to be rather that while sensation does indeed underlie the account of the *pathemata*, at the same time it would equally underlie the account of ‘flesh’ and of ‘the mortal part of soul’. Plato’s point is that both subjects are essential to an understanding of sensation: but that both subjects cannot be treated of at once.

(iv)

For the division of labour announced at 61C4ff. in fact falls, clearly and indisputably, between the account of the *pathemata* which concludes the second part of Plato’s treatise and the opening pages of the third part of the treatise.

In the third and final part of Plato’s treatise, the lesser gods begin their activity by implanting the mortal part of soul in the chest and belly.¹⁴ The housing of the mortal soul in these two parts of the body determines the disposition of heart, blood and veins, and is accompanied by an elaborate account of the liver, active in dreams and divination, and of the spleen, which keeps the liver in good order.¹⁵

The section which follows is introduced explicitly as an account of bones and different kinds of flesh.¹⁶ It includes a detailed description of the formation of marrow, including brain, of bone, which is protected by sinews and flesh, of skin, hair and nails.¹⁷

These therefore are the pages which correspond to the two subjects which Plato had postponed when introducing his account of *pathemata* (61C4ff.).

¹⁴ 69C5ff.; for the three parts of the treatise, see pp. 107-8 above.

¹⁵ Heart, blood, veins, 70A7-C1. The position of the heart determines the position of the lungs, 70C1-D6. Liver, 71A3-72C1. Spleen, 72C1-D3. For blood, see also 80D1-81B5.

¹⁶ 73B1ff.: τὸ δὲ ὅστων καὶ σαρκῶν καὶ τῆς τοιαύτης φύσεως περὶ πάσης ὥδε ἔσχεν.

¹⁷ Marrow, including brain, 73B2-E1. Bone, 73E1-74A7, protected by sinews and flesh, 74A7ff. Skin, 75E5-76B1. Hair, 76B1-D3. Nails, 76D3-E6.

The interlocking of both subjects with the *pathemata* is explicitly brought out in Plato's text. The *phronimon* and the mortal soul or more simply 'soul' are taken for granted in Plato's account of pleasures and pains and of hearing; so too are bone and hair, in the account of pleasures and pains, and brain, blood and liver in the account of hearing.¹⁸ Conversely, the account of mortal soul begins with a reference to *pathemata*, specifically the *pathemata* of pleasure and pain, while 'sweet' and 'bitter' recur in the account of the liver.¹⁹ In both sections there are frequent references to *aisthesis*.²⁰

It is impossible to see, in the passing reference to 'soul' in Plato's account of hearing (67B3), the exposition of mortal soul which has been postponed at 61D5, as Taylor's interpretation would require. On the contrary, Plato obviously takes for granted in his account of hearing (67A7ff.), and in his account of pleasure and pain (64A2ff.), the detailed description of the housing of the mortal soul which occupies the opening pages of the third part of his treatise (69C5ff.).

Clearly, *this* must be the part of his analysis of *aisthesis* which Plato has postponed. The introduction which I have quoted to the account of the *pathemata* (61C4-D5) must therefore cover *both* the common *and* the particular *pathemata* (61D5-68D7). The subjects which Plato has postponed, 'flesh' and 'the mortal parts of soul', are dealt with in the third part of Plato's treatise (69A6ff.), *after* the description of the particular *pathemata* (65B4-68D7).

(v)

Why then has Taylor been unable to see the obvious?

There are more remote reasons, which I touched upon earlier: Taylor's preoccupation with finding in Plato Whitehead's sense-objects, his willingness to allow himself therefore a whole host of anachronistic terminology ('cartilages', 'tendons', 'organic tissues') and jargon ('descriptive physics', 'sense-physiology', 'psychophysics', 'psycho-

¹⁸ Pleasures and pains 64A2ff.: the *phronimon*, 64A5; bone and hair, C4; the mortal soul, 65A5. Hearing, 67A7ff.: 'soul', B3; brain, blood and liver, B3-5. On the *phronimon*, see § 4, pp. 138-43 below.

¹⁹ *Pathemata* in the introduction to mortal soul, 69C8-D2. 'Sweet' and 'bitter' in the account of liver, 71B2. See also 'soft', 'hot', 'cool', in the account of flesh and sinews, 74C1ff.

²⁰ 'Sensation' underlies the whole of the account of the *pathemata* (61D5-68D7), as Plato had said it would. It would be artificial to single out isolated expressions. The same is true of the account of mortal soul and of flesh etc. (69C5ff.): 'sensation' is mentioned in the introduction to the account of mortal soul (69D4), and in the details of Plato's description (70B6, B7, 71A4). But singling out isolated expressions is again artificial: differences of sensitivity or of perceptivity dominate the whole account of bone, and of the coverings provided for bone by sinews and flesh, skin and hair (74A7-76D3; cf. p. 167 below).

physiology').²¹ But the immediate reason lies in Taylor's initial misunderstanding of the meaning for Plato of *pathemata*. Taylor starts out from the assumption that the *pathemata* are 'characters of the various bodies themselves' and not 'effects produced by the bodies on a percipient'. This distinction is impossible to maintain when Plato deals with the *pathemata* of the particular senses. Therefore Taylor seeks to restrict his sense of *pathemata* to the common *pathemata*, and to make out therefore that the particular *pathemata* are somehow contrasted to these as a 'postulate' which Plato postpones.

This whole procedure makes nonsense of Plato's text.

In fact, it is clear that, from the point of view of Plato's initial 'postponement', both the common and the particular *pathemata* belong to a single analysis, and are jointly distinguished from the account of mortal soul and the formation of flesh and bone which follow the account of the particular *pathemata*.

Moreover, Plato's transition from the common to the particular *pathemata* makes clear that in both cases he intends his analysis to include the *pathemata* or *pathe* no less than the agents which produce them. What Plato means by this is immediately clear from the analysis of freezing. Plato will explain why it is that we apply the name 'cold' both to the *pathos*, 'I feel cold', and to the agent which makes us cold, 'a cold wind', 'cold water'.²²

The *pathemata* therefore, the common no less than the particular *pathemata*, cannot be restricted to meaning 'the characters of the various bodies themselves'. They must be, or at least they must in some way include, the 'effects produced by the bodies on a percipient'.

§ 3. CORNFORD'S 'PATEMATA'

(i)

Cornford rightly sees that 'flesh' and 'the mortal part of soul' are treated only in the final part of Plato's discourse. Cornford therefore rightly appreciates that the distinction between *pathemata* and the subjects which Plato postpones falls not between the common and the particular *pathemata*, but between both kinds of *pathemata*, taken together, as distinct from the treatment of mortal soul and of flesh, bone, blood etc., in the final part of the treatise.

But Cornford is wrong, it seems to me, in the interpretation which he gives of the distinction immediately preceding: between *gene* and *pathemata*.

²¹ Cf. *Commentary* 430, 445, 464.

²² *Tim.* 62B2-6; cf. pp. 113-14 and 129-30 above.

1. The account of the *gene*, Cornford supposes, Plato means to restrict to 'objects ... as they are supposed to exist in their own right, independently of the effects which they produce in commerce with sentient organs', to 'those properties which bodies are supposed to possess in the absence of any sentient being, such as the shapes of the microscopic particles, which are never perceived'.

2. The *pathemata*, on the other hand, are intended to be the qualities of white or of hot such as they have been described in the *Theaetetus*: qualities which exist only if, and for so long as, they are perceived to exist.²³

But while Cornford's preoccupation with the *Theaetetus* is more forgivable than Taylor's preoccupation with Whitehead, the results are not dissimilar. For neither of the two classifications in the *Timaeus*, that of the *gene* and that of the *pathemata*, answers in practice to the distinction which Cornford has sought to impose from his study of the *Theaetetus*.

Thus Cornford has to admit that hard and soft, in Plato's account of the *pathemata*, are not limited to the 'affections' of a sentient being.

'...Plato himself remarks that bodies are called hard or soft "with reference to one another", apart from any sentient organ.'²⁴

It is equally an embarrassment that 'hard' and 'soft', along with 'cooling' and 'sweetness' and 'bright', appear in the account of the *gene*.²⁵ For hot and hard and white are precisely the properties which illustrate the theory of the *Theaetetus*. Such properties, Plato tells us in that dialogue, can arise only through the conjunction of perceived object and percipient: how then is it that in the *Timaeus* they appear among the *gene*, before the account of sensation and perception?²⁶

How is it that 'hard', 'soft', 'cooling', 'sweetness', 'bright', all appear in a section of the treatise where, according to Cornford, Plato's preoccupation should be exclusively with 'those properties which bodies are supposed to possess in the absence of any sentient being'?²⁷

²³ *Cosmology* 258-9; cf. p. 124 above.

²⁴ *Cosmology* 262. I have already emphasised, pp. 110-13, the importance of the phrase πρὸς ἀλλήλα τε οὕτως (62B7-8); see further p. 150 below.

²⁵ 'Hard' (σκληρότατον, σκληρότερον), of *adamas* and copper, 59B5 and 8, cf. pp. 89-96 and 111-12 above. 'Soft' (μαλακόν), of water, 59D6, cf. pp. 109-11 above. 'Cooling' (ψύξιν), of metals, 59A7, cf. pp. 113-14 above. 'Sweetness' (γλυκύτητα), in the account of honey, 60B2, cf. pp. 116-17 above. 'Bright' (λαμπρῶν, λαμπρόν), of metals, 59C2, and of oil, 60A6.

²⁶ Cf. *Theaet.* 156A3-157C2, 182A3ff. Plato attributes the theory to some 'more sophisticated' thinkers (χομψότεροι, 156A3); but Cornford takes the ideas put forward to be Plato's own, *Plato's theory of knowledge* 48ff.

²⁷ 'Sweetness' is something of an exception, since Plato tells us only that honey 'has the power to produce sweetness' (60B1-2; cf. pp. 116-17 above), which gives Cornford an ob-

(ii)

This second discrepancy, however, the appearance of hard and soft, and cold and sweet and bright, among the *gene*, Cornford fails to appreciate as clearly as the discrepancy of hard and soft being included, even for non-sentient bodies, among the *pathemata*.

The reason, I think, lies in a slight, but treacherous, misunderstanding of the same passage which leads Taylor astray, and which I have already quoted, where Plato first introduces the account of *pathemata*.²⁸

Cornford appears to think that Plato apologises, as it were, for having *anticipated* his account of sensation in the analysis which he has *already* given of the existence of objects 'as they are supposed to exist in their own right'.

'So far these objects have been considered as they are supposed to exist in their own right, independently of the effects which they produce in commerce with sentient organs. But, as Plato now remarks, since our knowledge of their existence is due entirely to sensation and perception, their properties could not be mentioned save in terms implying our perception and so anticipating the account, which has not yet been given, of the organs of sense and the sentient part of soul.'²⁹

But in fact when Plato writes that ὑπάρχειν αἴσθησιν δεῖ τοῖς λεγομένοις αἰ (61C6), it is more natural, I think, to take him to mean, not that sensation has been presupposed by the account which he has *already* given, but that sensation is presupposed by the account which is *now* being given, i.e. subsequently to the introduction of the *pathemata* (61C4ff.).

For the dilemma which Plato faces lies not in the mutual entailment of *gene* and *pathemata*, but in the mutual entailment, as factors which are equally implicated in the analysis of sensation, of the *pathemata* on the one hand, and on the other hand of 'flesh' and 'the mortal part of soul'.

1. An account of the *pathemata* will presuppose *aisthesis*, for which an understanding of the formation of flesh and of the mortal part of soul is indispensable.

2. Conversely, an account of *aisthesis*, as dependent upon flesh and upon the mortal part of soul, would presuppose the *pathemata*.

Plato cannot write of both subjects at once: *aisthesis* from the point of view of flesh and the mortal soul, and *aisthesis* from the point of view of the

vious opening to gloss the text of the *Timaeus* with the theory of the *Theaetetus* (cf. *Cosmology* 254 n. 5). In the other cases I have listed, the property ('hard', 'soft', 'bright') or the process ('cooling') is attributed directly to the object; these passages Cornford lets pass without comment.

²⁸ 61C4-D5, quoted above, p. 130.

²⁹ *Cosmology* 258.

pathemata. He chooses the second course. He will give first an account of the *pathemata*, as this follows best from his analysis of the *gene*, and he will postpone the other factors required for an understanding of *aisthesis*: flesh and the mortal part of soul.³⁰

(iii)

I conclude that neither Taylor's interpretation nor that of Cornford can be correct.

1. The *pathemata* which Plato describes cannot be intended as 'characters of the bodies themselves', as Taylor supposes, to the exclusion of 'effects produced by the bodies on a percipient'.

2. Cornford comes closer to the mark, in seeking to find in the *Timaeus* a repetition of the theory of the *Theaetetus*. But again the text of the *Timaeus* simply does not answer to the distinction which Cornford proposes, between *gene* which lack any properties which we can be aware of in sensation, and *pathemata* as properties which exist exclusively 'in commerce with sentient organs'.

Plato's conception of *pathemata* must be looked at afresh, without the supposition that 'hot' and 'hard' exist as properties of the objects themselves, independently of their effect upon us, and at the same time without, for the moment, subordinating the teaching of the *Timaeus* to that of the *Theaetetus*, and therefore allowing 'hot' and 'hard' to exist, and be spoken of, only in conjunction with a sensible percipient.

³⁰ It will be seen that I adopt essentially the interpretation given by Shorey of these two sentences (61C6 and D4): 'In all we are going to say the existence of sensation must be assumed', and 'In order that we may take up the παθήματα next in order after the γένη (i.e. without interposing the discussion of the mortal soul, etc., logically required).' See P. Shorey, 'The *Timaeus* of Plato', *AJPh* 10 (1889) 45-78, esp. 71-2. Taylor acknowledges Shorey's interpretation, implicitly and in passing, *Commentary* 430, but has clearly not thought out the implications of it; see Shorey's later remarks in 'Recent interpretations of the *Timaeus*', *CPh* 23 (1928) 343-62, esp. 359.

There is no need to re-consider the earlier interpretation, corrected by Shorey, but from which Cornford's interpretation in part derives: 'First we must assign to all the substances we have described the property of causing sensation', and 'In order ... that the properties of the several elements may be discussed in due order' (Archer-Hind, edn 225-7). Archer-Hind's 'retrospective' interpretation of Plato's 'postponement' persists in the passage I have quoted from Cornford's commentary (*Cosmology* 258), although curiously Cornford's translation of the passage (*Cosmology* 258: 'Our account at every point must assume the existence of sensation') seems to have been taken over from the translation which Shorey provided in his correction of Archer-Hind.

Giuseppe Fraccaroli's translation, *Platone, il 'Timeo'* (Torino, 1906) 292 ('a qualsiasi cosa di cui si parli ha da corrispondere sempre una sensazione') and interpretation (p. 292 n. 2: 'la materia è l'oggetto del senso, dunque bisogna considerarla non astrattamente da sè', etc.) is at once too grandiose and too far removed from Plato's immediate preoccupation.

§ 4. 'PATHEMATA' AND 'AISTHESIS'

The truth is that *pathemata* occupy a position midway between the features which are inherent in an object and which give rise to sensation and the actual sensible awareness which is registered in a human or an animal percipient. The *pathemata* in themselves are therefore neither the 'characters of the bodies themselves', as Taylor believes, nor is it quite the case that the *pathemata* exist only when, and for so long as they are being perceived, as is true of the *sensibilia* in the *Theaetetus*. The *pathemata*, Plato makes reasonably clear, are the effects which one body produces upon another, and which in cases where the body which is affected is a sentient body may or may not give rise to *aisthesis*.

(i)

Plato's general intention is made clear in a series of passages which describe the *pathemata* as they affect the newly incarnate soul, whose composition and embodiment Plato relates at the end of the first part of his treatise. The following two passages are especially informative.³¹

The demiurge informs the as yet unembodied souls of the life that awaits them on earth. He told them that 'when particular souls were implanted in mortal bodies, as by necessity they would have to be, and when the body that belonged to them was caught in an alternating process of accretion and secretion, then the first effect that followed was *aisthesis*, a faculty of perception that would be implanted <in us> and that would be one and the same for all <of us>, and that of necessity would be produced out of the violent *pathemata* that fell upon <the soul> ...'. Plato writes, 42A3-6: ὁπότε δὴ σώμασιν ἐμφυτευθεῖεν (*sc.* ψυχαί) ἐξ ἀνάγκης, καὶ τὸ μὲν προσίοι, τὸ δ' ἀπίοι τοῦ σώματος αὐτῶν, πρῶτον μὲν αἰσθησιν ἀναγκαῖον εἶη μίαν πᾶσιν ἐκ βιαιῶν παθημάτων σύμφυτον γίγνεσθαι ...

The following is then part of the description of the experiences that greet the newly incarnate soul, when the predictions of the demiurge are realised: 'Great as was the flood that in its surging ebb and flow brought nourishment to the creature, greater still was the turmoil wrought by the *pathemata* of the things that fell upon each and every creature, whenever the body of a creature stumbled upon alien fire that it met with in the world outside, or upon a solid block of earth, or upon waters wet and slip-

³¹ I have not chosen these two passages at random. As both Archer-Hind, edn 143, and Cornford, *Cosmology* 143 n. 2, have recognised, the description of the violent *pathemata* which attach to the newly incarnate soul, at the end of the first part of Plato's treatise (41Dff.), is deliberately picked up again when Plato returns to describe the housing of the mortal part of soul within the human frame, at the beginning of the third part of his treatise (69Aff.; note especially the δεινὰ καὶ ἀναγκαῖα ... παθήματα, 69C8-D1).

pery, or was caught hold of by the blast of winds borne through the air, and whenever the movements from all these <elements and from the *pathemata* they brought with them> were carried through the body and fell upon the soul; whereupon they were then called, and are now called, all of them alike "sensations".' Plato writes, 43B5-C7: πολλοῦ γὰρ ὄντος τοῦ κατακλύζοντος καὶ ἀπορρέοντος κύματος ὃ τὴν τροφὴν παρεῖχεν, ἔτι μείζω θόρυβον ἀπηργάζετο τὰ τῶν προσπιπτόντων παθήματα ἐκάστοις, ὅτε πυρὶ προσκρούσειε τὸ σῶμά τινος ἔξωθεν ἄλλοτρίῳ περιτυχὸν ἢ καὶ στερεῶ γῆς πάγῳ ὑγροῖς τε ὀλισθήμασιν ὑδάτων, εἴτε ζάλῃ πνευμάτων ὑπὸ ἀέρος φερομένων καταληφθεῖη, καὶ ὑπὸ πάντων τούτων διὰ τοῦ σώματος αἱ κινήσεις ἐπὶ τὴν ψυχὴν φερόμεναι προσπίπτουσιν· αἱ δὲ καὶ ἔπειτα διὰ ταῦτα ἐκλήθησάν τε καὶ νῦν ἔτι αἰσθήσεις συνάπασαι κέκληνται.

From these two passages it is clear that *aisthesis* arises from the *pathemata* or, to put it the other way round, that the *pathemata* produce *aisthesis*.

At the same time, it is clear that the *pathemata* are not themselves *aisthesis* or *aistheseis*. *Aisthesis* arises out of the *pathemata*, in the first passage. In the second passage, it is only when the movements arising from the *pathemata* arrive at the soul that they are called *aistheseis*.³²

(ii)

The *pathemata*, I think we may conclude, are therefore a necessary cause, or condition, of *aisthesis*. But they are not a sufficient condition. For Plato's account of pleasure makes it clear that the *pathemata* do not invariably give rise to sensation.

Plato begins his analysis of pleasure with an account of 'the reasons for any *pathema*, perceptible or imperceptible, 64A6-7: ὧδ' οὖν κατὰ παντὸς αἰσθητοῦ καὶ ἀναισθήτου παθήματος τὰς αἰτίας λαμβάνωμεν ... In the analysis that follows (64A7-C7), sensation or perception is made dependent upon the confluence of two factors: the *pathos* which 'falls upon' the body, and the nature of the body which receives the *pathos*. The nature of the recipient can be of two kinds. A mobile recipient passes on the message, from one part of the body to another, until the particles which have been set in

³² I take it to be a rather different use of *aisthesis* from those I have transcribed above, when Plato writes of 'certain *aistheseis* arriving from without and falling upon the soul', 44A5-6: αἷς δ' ἂν (sc. ψυχαῖς) ἔξωθεν αἰσθήσεις τινὲς φερόμεναι καὶ προσπεσοῦσαι ... It is significant that these *aistheseis* are summarised, a few lines later, as *pathemata*, 44A7-8: καὶ διὰ δὲ ταῦτα πάντα τὰ παθήματα. Essentially the same analysis is given of vision, but in terms of κινήσεις and not *pathemata*; this slight change in terminology is probably necessitated by the active rôle of the visual ray, which moves out from the body to find its object (45C2-D3). Vision is specifically included among the *pathemata* mentioned in the analysis of pleasures and pains (64C5-7; the whole passage, 64A6-C7, is summarised immediately below). For a similar use of *pathos*, cf. *Theaet.* 179C3.

motion 'reach the seat of the intelligence (τὸ φρόνιμον) and <there> announce the <nature and> power of the body which has set them in motion (τοῦ ποιήσαντος τὴν δύναμιν)'. A sluggish recipient is affected by the impulse from without, but it does not pass the impact on to other parts of the body, so that in this case 'the body which received the *pathos*' (τὸ παθόν) is left 'without sensation' (ἀναίσθητον).

From this it follows that the *pathemata* are not in themselves 'sensations' or 'perceptions'. For Plato does not draw any distinction between the *pathe*, in his account of the distinction between what is perceptible and what is imperceptible. Indeed, he emphasises that a mobile recipient will carry a message to the *phronimon* 'whenever even a brief *pathos* falls upon it' (ὅταν καὶ βραχὺ πάθος εἰς αὐτὸ ἐμπίπτῃ, 64B3-4). The distinction between what is perceptible and what is imperceptible is determined not by a difference between the *pathemata*, but by a difference in what happens to the *pathemata*, when they reach a (potentially) sentient recipient.

Thus the *pathemata* or *pathe* will be recognised by the *phronimon*, the seat of consciousness and intelligence, only if they strike upon an appropriately receptive part of the body. If the *pathos* hits 'bone or hair or any of the other parts in us that are made of earth', then the force of its impact will go no further. If, on the other hand, it hits our flesh, or other suitably sensitive parts of our body, then it will stand a chance of being transmitted to the seat of the consciousness or the intelligence, where it will be recognised as, and will therefore become, a sensation.³³

(iii)

This explains Plato's dilemma, when he turns from his account of the *gene* to his account of the *pathemata*.

The *pathemata* are necessary for an understanding of *aisthesis*. But *aisthesis* also requires an understanding of 'flesh, and things associated with flesh', and of 'the mortal part of soul', for only certain kinds of 'flesh, and things associated with flesh' are capable of transmitting the *pathemata* to the seat of consciousness and intelligence. Therefore it is impossible properly to understand *aisthesis*, without understanding at once

³³ The *phronimon*: my various periphrases will, I hope, be sufficient indication I mean to by-pass any more detailed analysis of this very interesting term, and that I am treating it here simply as that part, or function, of the mortal soul which is needed for the reception of *pathemata*, and their subsequent recognition as *aistheseis*. There is, for example, an obvious problem when we are told that plants have 'the sensation of pleasure and pain, with desires', although they have no 'faculty of opinion or of calculation or of intelligence' (77A3-C5). This problem remains unsolved, in an otherwise useful study of this passage by J. B. Skemp, 'Plants in Plato's *Timaeus*', *CQ* 41 (1947) 53-60. For a similar preoccupation in the *Theaetetus*, cf. 184D.

the nature of the *pathemata* and the nature of 'flesh and things associated with flesh', and yet it is impossible to analyse both subjects at once. Plato chooses to speak first of the *pathemata*.³⁴

How this choice affects Plato's account, we see spelt out exactly in the preliminaries which I have quoted to the analysis of pleasure and pain, 'the last and the greatest of the common *pathemata*' (64A2ff.). There Plato has to presuppose, to 'hypothesise', precisely those elements which he had listed earlier: the mortal part of soul, which appears here as the seat of consciousness, the *phronimon* (64B5), and 'flesh and things associated with flesh', which appear here in the distinction between the insensitive parts of the body, hair and bone (64C4), and the receptive parts of the body, which Plato specifies as to do with sight and hearing, and which he tells us are especially sensitive 'because of the power of the fire and the air that is in them' (64C5-7).

Thus the subjects which Plato must here 'hypothesise', in his account of pleasure and pain, are precisely the subjects which he will pick up and explain in the third and final part of his treatise. In particular, in the final part of his treatise, Plato describes the formation of hair and bone, and much play is made of the discrepancy between their insensitivity on the one hand and on the other hand their ability to protect various parts of the body (73B1-76E6).³⁵

Conversely, in the final part of his treatise, Plato is able to take for granted the *pathemata*, precisely in accordance with the plan which he had announced in first turning from the study of the *gene* to study of *pathemata*. Thus in the final part of his treatise Plato writes that the lesser gods 'fashioned a dwelling for another kind of soul, a mortal soul', which keeps with it 'strange and unavoidable *pathemata*', of which the first pair are precisely pleasures and pains (69C5-D6). The transmission of these *pathemata* to the various centres of the body where soul resides are then described in great detail (69D6-70D6, and from a slightly different point of view, 70D7-72D3).

At the same time, we must beware of looking in these later pages for a description of the sense organs as such, which both Cornford and Taylor seem to think that Plato has promised.³⁶ The truth is that Plato describes only one organ of sense, and that only once: the structure of the eye is described at the end of the first part of the treatise (45B2-46C4), because

³⁴ 61C4-D5, quoted above p. 130.

³⁵ More detailed references, p. 132 above.

³⁶ Cornford, *Cosmology* 258, quoted above p. 136. Taylor, *Commentary* 464, quoted above p. 131.

of its overriding importance in providing man with sight of the 'visible gods', and the perfect order and beauty they display.³⁷

Sound and hearing are also mentioned briefly after the account of vision (46C4-E2), but they are not defined until the penultimate section in Plato's account of *pathemata*. Sound is 'a blow inflicted by air, through the ears, on the brain and the blood, and transmitted to the soul' (67B2-4). Hearing is 'the motion caused thereby' and passing through the body, 'starting from the head and finishing at the liver' (67A7-B5). What needs to be explained therefore, in order to complete our understanding of these two definitions, is not anything to do with the structure of the ear, so much as an account of soul, brain, blood and liver: all of which are in fact duly described in great detail in the final part of the treatise; as also is the nature of flesh itself, which is composed in such a way that 'it yields softly and gently to bodies', precisely what we needed to know to complete our understanding of the *pathemata* of hard and soft.³⁸

(iv)

A proper analysis of 'sensations' therefore depends on an understanding of two factors: the nature of the *pathemata* which enter the body, and the nature of the recipient, 'flesh and things associated with flesh', which are capable, or incapable as the case may be, of transmitting the various kinds of *pathemata* to the soul.

³⁷ The assumption that in the *Timaeus* Plato intends to describe the organs of sense is very widespread: for example, in the summary of the *Timaeus* given by Richard Kapferer and Anton Fingerle, *Platon's 'Timaios' ... übersetzt und erläutert* (Stuttgart, 1952) 14-16, we find announced 'Physiologie der Sinnesorgane und Nerven' at 41D4ff. and 'Die Sinnesorgane und die Sinne' both at 45B2ff. and again at 61D5ff.

³⁸ The mortal part of soul, 69C5-72D3. Brain, 73C6-D2. Blood, 80D1-81B5, cf. 70A7-C1. Liver, 71A3-72C1. Flesh, 74A7-D2, esp. 74B7-C1: τὴν δὲ σάρκα ... σώμασιν μαλακῶς καὶ πρῶως ὑπείκουσαν. For the definition of hard and soft among the *pathemata*, 62B6-C3, see ch. VI § 2, pp. 109-13 above. In the final section of his account of *pathemata* (67C4ff.), Plato defines only colours and not vision, precisely because the working of the eye has already been described at the end of the first part of the treatise (45B2-46C4).

The definition of sound is initially ambiguous, 67B2-4: φωνὴν θῶμεν τὴν δι' ὠτων ὑπ' ἀέρος ἐγκεφάλου τε καὶ αἵματος μέχρι ψυχῆς πληγὴν διαδιδόμενην. I have given these words the meaning which Theophrastus apparently gives them (*De sens.* 6 and 85: the blow is inflicted through the ears, by the air, on the brain and blood), and not the meaning which Aetius gives them (iv 19.1: the blow is inflicted by the air and transmitted through the ears, brain and blood). Archer-Hind defends the former meaning in his note, edn 246, but gives the latter meaning in his translation, edn 247. To prove that Aetius has 'quite misunderstood' Plato's construction, Taylor, *Commentary* 476-7, criticises at length the definition Aetius gives of hearing (iv 16.4) and ignores the definition he gives of sound (iv 19.1). Is it surprising that these two writers should have the general sense and architecture of Plato's treatise so badly out of focus, when the details of the text are handled so roughly?

The *pathemata* are not therefore characters of 'hot' or 'cold' which reside in an object independently of its effect upon a sensible percipient, as Taylor supposes.

Equally, the *pathemata* are not themselves quite the same as the *sensibilia* of the *Theaetetus*, qualities of 'white' or 'hot' which exist only when, and for so long as, they are being perceived.

The *pathemata* are simply the effects which one body has upon another and which if the body affected is sufficiently receptive will be transmitted to the *phronimon* and will thereby be recognised as sensations.

CHAPTER EIGHT

THE CONCILIATION OF THE TWO THEORIES

§ 1. THE 'TIMAEUS' AND THE 'THEAETETUS'

The conclusion of the preceding chapter, on the relation of *pathemata* to *aisthesis*, presents us with a theory which, at least on a fairly general level, does conform to the theory of the *Theaetetus*, as Professor Cornford thinks that it should.¹

But the differences will prove to be as important as the similarities.

(i)

A general confluence of the ideas and preoccupations in Plato's two treatises is indicated by a passage early in the *Timaeus*, where Plato gives as a 'short-cut' reason for believing in the existence of forms—'*eide* that we cannot perceive by the senses but that can be recognised by the mind alone'—the distinction between 'intelligence' or 'knowledge' and 'true opinion'. If those two cannot be distinguished, then there will exist only what we can perceive with the body. But if 'intelligence' and 'true opinion' are not the same, then there must exist forms of fire and the like (51D1-52A7).

The distinction between 'intelligence' and 'true opinion' is the central preoccupation, especially of the later parts of the *Theaetetus*. According to Cornford's interpretation of the dialogue, the *aporia* that results from any attempt to reduce 'knowledge' to sensation or opinion, even true opinion, is intended, implicitly, to establish the indispensability of Plato's theory of forms.²

If this interpretation of the *Theaetetus* is taken as correct, then the lesson of that dialogue will answer more or less to the argument which Plato offers briefly, but explicitly, in the *Timaeus*. If knowledge and true opinion are the same, then there need be no forms. If knowledge cannot be reduced to true opinion, then there must exist forms, whose apprehension, or contemplation, by the human intellect will constitute, or will be a necessary criterion of, knowledge.³

¹ *Cosmology* 259. *Plato's theory of knowledge*, esp. 45-51. Cf. p. 124 above.

² *Theaetetus*, esp. 187Aff. Cornford, *Plato's theory of knowledge*, e.g. 106, 109, 110-11, 140, 158, 162-3. Cf. William D. Ross, *Plato's theory of ideas* (Oxford, 1951) 124-5.

³ Cf. *Plato's theory of knowledge* 141-2. I hope that these and the very brief remarks which follow on the more general interpretation of the *Theaetetus*, and the possibility of its conciliation with the *Timaeus*, will not be taken amiss. The whole subject is of course a highly

(ii)

More specifically, Cornford claims that the theory of sensation offered in the earlier part of the *Theaetetus* must be intended by Plato as a true account, since a denial that knowledge could be equated with a *false* account of sensible perception would not adequately have shown that knowledge cannot be reduced to sensation. Cornford therefore hopes to find in the *Timaeus* the theory of the *Theaetetus*.⁴

The account of sensation which Plato outlines in the earlier part of the *Theaetetus* rests on the idea that the perception of a sensible quality, 'white' or 'hot', cannot be said to arise from, or to exist in, either the perceived object or the percipient, taken alone, but only in the conjunction of the two.⁵

This could be taken to be more or less the theory of the *Timaeus*. 'Whiteness' or 'heat' do not directly belong to, or reside in fire, as many of the fifth-century philosophers had thought of them as doing. In the *Timaeus*, as in the *Theaetetus*, 'white' and 'hot' do arise only from the conjunction of perceived object and percipient.

Where the *Timaeus* differs from the *Theaetetus* is in telling us what it is that does reside in fire, such that when we look at fire, or come close to it, we see white and feel hot. The *Theaetetus* establishes the principle only. The *Timaeus* provides the explanation of the fact.

What exists, at least in the world of becoming as distinct from the world of form, are tetrahedra, whose sharp edges and pointed angles cut into the substance of our flesh and are 'symmetrical' to the fire which streams from the eye.

The result is that when the tetrahedra of fire hit upon our flesh or are joined to the light from an eye then the *pathema* is conveyed to some kind of central sensorium—to use an anachronistic but more familiar expression for what Plato calls the *phronimon* or 'the mortal part of soul'—with the result that we 'see white' and 'feel hot'.⁶

controversial one: I shall be concerned here solely with the question of the two theories of sensation, and my very limited conclusion on that point could be adapted in more than one way to more general conclusions on the relation between the two treatises. I have also limited my remarks to Cornford's interpretation of the two works; other more recent commentaries (e.g. John McDowell, *Plato 'Theaetetus', translated with notes*, in the *Clarendon Plato series* [Oxford, 1973] esp. 257-9) take a less simple, and more aporematic, view.

⁴ *Plato's theory of knowledge*, esp. 49, 58-9, 96-7. This is also the conclusion of G. Nakhnikian, although his arguments are of very uneven quality: see the second part especially of his study, 'Plato's theory of sensation', *Review of metaphysics* 9 (1955-6) 129-48, 306-27.

⁵ *Theaetetus*, approx. 153D8-160E3; cf. 182A3ff.

⁶ Vision: 45B2-46C6, 58C5-D1, 64C5-7, 64D3-E4, 67C4-68D7. Temperature: 56A5, 56E8-57A2, 58D8-59A8, 59A1-8, 59D4-E5, 61D5-62B6; cf. pp. 113-15 above.

(iii)

From this point of view we can avoid, as Cornford would wish, any obvious contradiction between the teaching of the *Timaeus* and the *Theaetetus*. But equally, this level of generalisation gives us little insight into the structure and purpose of either treatise.

In particular, even on this level of generality, there remains the apparent anomaly that in the *Timaeus* Plato uses the language of sensible experience, 'hot' and 'white', not only to describe the conjunction of perceived object and percipient, but equally in his account of the *gene*, and of the relation and interaction of the *gene*, one with another. Does it not offend against the theory of the *Theaetetus* to speak of copper or *adamas* as 'hard', or 'light', of water as 'soft', of metals as 'cooling'?⁷

It is in attempting to answer this question, rather than in seeking a level of generality where the two theories can be identified, that I think we see more clearly into Plato's intentions.

For although it is true that the two theories can be reconciled, nonetheless Plato's two works differ radically in their objective: the *Theaetetus* is revisionary—to borrow and adapt a piece of contemporary terminology—or at least exploratory, while the *Timaeus* is expository and explanatory.

(iv)

Thus in the *Theaetetus* Plato's purpose, in enquiring into the true meaning and nature of knowledge, is to offer a radical reappraisal of the nature of our sensible perception. In such an enterprise, Plato, in the person of Socrates and his respondent, is willing, if not eager, to undercut the conventional significance of current terminology.

Thus Socrates tells Theaetetus, 157A7-B3:

'From this whole account' of the interdependence of perceived object and percipient 'the point which I made at the beginning still holds: namely that nothing' in the sensible world 'exists in and by itself, but is always in a process of becoming, in relation to or in dependence upon, some percipient.

'Consequently, the notion that something "exists" must be rooted out from every such circumstance, although of course I do not deny that as often as not we are compelled, as we were just now, to go on using the term "exist", because our minds are clouded by habit.'

The convention is as old as Empedocles. 'Birth' and 'death' do not exist. There is only mixture and separation. 'But I too will follow the convention of language.'⁸

⁷ Copper and *adamas*, 59B4-C3; see above pp. 89-96 and 111-12. Water, 59D6; see above pp. 110-11. Metals and 'cooling', 59A7; see above pp. 113-14.

⁸ Cf. fr. 8 and 9, esp. fr. 9.5: <ού> θέμις <ῆ> καλέουσι, νόμῳ δ' ἐπίφημι καὶ αὐτός. For the reading, cf. *ECC* 165 n. 6.

The purpose of the *Timaeus*, or at least of the central portion of the *Timaeus*, runs in just the opposite direction. Here, Plato's purpose is to demonstrate, as cosmologists had traditionally been concerned to demonstrate, that the principles of his physical philosophy are sufficient to account for the whole range of our experience of sensible phenomena.

For the conventional concern of fifth-century cosmology, to which at least in this respect Plato adheres, is precisely to stress that the extreme variety of our experience can be persuasively and convincingly reduced to a limited number of facts and principles. The explanatory burden of such a system then lies largely in demonstrating the ability of these simpler facts, or these fewer constituents, to explain the enormous variety of detail that we are in fact familiar with. In this sense, the *Timaeus* is reductive and, in a sense, conservative, where the *Theaetetus* is revisionary or exploratory.

Now the process of reduction must necessarily take as the goal of its explanation the world which we do in fact perceive, for to deny, or at least to emphasise the denial, that certain features of our experience are true or significant would be, in a sense, a confession of impotence. Even if Plato does not believe that there truly exists, in the sensible world, 'any one thing in and by itself', he must at least be able to explain, if he is to be able to offer his choice of principles as a viable explanation of the sensible cosmos, why it is that such things *appear* to us as they do, why it is that we *speak of* fire as 'hot', of water as 'soft', of copper as 'hard' or of gold as 'heavy'.

And this, in fact, is all that Plato does.

For in the *Timaeus* Plato does not say, at least he does not habitually say, that fire *is* hot, or that metals *are* cooled, but that the account which he has provided of the primary solids explains why we *call* fire hot, and why metals are *spoken of* as being cooled.

§ 2. NAMES

(i)

This feature of Plato's writing, throughout his account of the *gene* and of the *pathemata*, is a degree too persistent to be accidental.

1. Of the kinds of air, the clearest and the brightest is the one 'called by the name of aether', 58D2: ἐπίκλην αἰθήρ καλούμενος.

2. There are other kinds 'without names', 58D3: ἑτέρα τε ἀνώνυμα εἶδη.

3. The entry of fire makes the fusible kind of water mobile, and the pressure of air forces it to spread over the ground. Melting and flowing 'are the names which attach to either *pathos*', 58E7: ἐπωνυμῖαν ἑκατέρου τοῦ πάθους ἔλαβεν.

4. The departure of fire 'is called cooling', and the compression that results 'is called solidification', 59A6-8: τὴν μὲν τοῦ πυρὸς ἀπαλλαγὴν ψύξιν, τὴν δὲ σύνοδον ... πεπηγὸς εἶναι γένος προσεργήθη.

5. The flower of gold 'is called *adamas*', 59B5: ἀδάμας ἐκλήθη.

6. The admixture of earth in copper, when it comes to the surface, 'is known as verdigris', 59C5: ἰὸς λέγεται.⁹

7. Water which flows over the ground 'is spoken of as liquid, and as soft', 59D5-6: ὑγρὸν λέγεται, μαλακὸν τε αὖ.

8. When the same kind of water is solidified from dew on the ground it 'is known as hoar frost', 59E5: πάχνη λέγεται.

9. The various kinds of water are mixed together to be 'known as juices', 60A1: χυμοὶ λεγόμενοι.

10. Many of them however 'have no names', 60A2-3: ἀνώνυμα γένη.

11. But four of them have been 'given names', 60A4: εἴληφεν ὀνόματα.

12. Honey is 'the general name' of one kind, 60B2-3: μέλι τὸ κατὰ πάντων μάλιστα πρόσρημα ἔσχεν.

13. Another kind 'is christened *oros*', 60B5: ὁπὸς ἐπωνομάσθη.

14. To one kind of earth 'we have given the name of earthenware', 60D2: κέραμον ἐπωνομάκαμεν.

15. The substance that chops our bodies into little pieces (κερματίζουσα) 'has appropriately given the name and the *pathema* to what we call hot (θερμόν/κερμόν)', 62A4-5: τοῦτο δ' νῦν θερμόν λεγόμεν εἰκότως τὸ πάθημα καὶ τοῦνομα παρέσχεν.

16. In the opposite case, 'the *pathos* and the agent which causes it have taken the name of cold', 62B5-6: ψυχρόν τε τὸ πάθος ἅπαν τοῦτο καὶ τὸ δρῶν αὐτὸ ἔσχεν ὄνομα.

17. Plato will tell us how it is that 'up' and 'down' have been 'named as they have been', 63A6: ὅθεν δὲ ὠνομάσθη ταῦτα.

18. When weight is defined by resistance, a large quantity of fire 'is designated as' heavy and as moving downwards, 63C4: κληθῆναι.

19. A small quantity of earth 'we deem to be' light, 63D3: προσειρήκαμεν.

20. Things that scrape and scour the tongue 'are called bitter', 65E1: πικρὰ πάνθ' οὕτως ὠνόμασται.

21. Other things 'are spoken of as pungent', 66A1-2: δριμέα πάντα τὰ τοιαῦτα ἐλέχθη.

22. I have already listed the terminology connected, or so I have argued, with *oros*.¹⁰ The various effects in question 'receive the name of' bubbles, 'are known by the name of' fermentation, and 'are spoken of as' sourness, 66B: κληθείσας ὄνομα ... ἐπίκλην λεχθῆναι ... προσρηθῆναι.

23. The opposite effect 'is called sweet', 66C7: κέκληται γλυκύ.

24. The two main kinds of smell 'have no name', but 'can be designated' only as pleasant and unpleasant, 67A1-3: ἀνώνυμα ... ἀλλὰ διχῇ ... λέγεσθον.

25. In the account of colours, black and white correspond to hot and cold and 'to what we called' astringent and pungent in the list of flavours, 67E2: ἐκαλέσαμεν.

26. Hence an agent which separates the visual ray, and one which contracts it, 'are to be called' respectively white and black, 67E5: προσρητέον.

⁹ Here and throughout, I use 'thinking' and 'speaking' indiscriminately for λέγειν in this context.

¹⁰ Pp. 118ff. above.

27. A mixture of fire and water is 'what we call a tear', 68A2: δ δάκρυον καλοῦμεν.

28. When our eyes water in a strong light 'we speak of the *pathos* as dazzling, and the agent of this same effect we call shining and sparkling', 68A6-B1: μαρμαρυγὰς μὲν τὸ πάθος προσείπομεν, τὸ δὲ τοῦτο ἀπεργαζόμενον λαμπρόν τε καὶ στίλβον ἐπωνομάσαμεν.

29. To another combination, 'we give the name of red', 68B4-5: τοῦνομα ἐρυθρόν λέγομεν.

After this long list, it is no surprise to learn that before god's intervention in the world 'none of the things that have names were in a fit state to be named', 69B6-7: οὔτε τὸ παράπαν ὀνομάσαι τῶν νῦν ὀνομαζομένων ἀξιόλογον ἦν οὐδέν. Clearly, the establishment of names is an important consequence, if it is not in a sense synonymous with, god's organisation of the universe 'by shapes and numbers' (53B5).¹¹

(ii)

Admittedly, I have cast my net wide in listing the establishment of names for the *gene* or *eide* no less than for the *pathemata*. But this duplication, I suspect, is essential to Plato's intention.

For the emphasis on naming throughout these pages seems to me not—or rather not only—a literary device. The whole list of items which have names, or which lack names, arises solely (so Plato would have us believe) from the various grades and combinations of the four primary geometrical solids. From the extreme multiplicity of names, it does not follow that there is an equivalent multiplicity of different kinds of primary elements.

But in the case of the *gene* there is an additional factor at work. For Plato's intention is that the naming of the *gene* should be effected by a transference from the *pathema* to the object which causes it.

Thus when we speak of ourselves as being dazzled, we give a corresponding name to whatever it is that dazzles us: 'shining' and 'sparkling' (68A6-B1). This was precisely what Plato had told us in his account

¹¹ For this expression, and its significance in Plato's theory, see pp. 107-9 above and 159-62 below. The pervasiveness of 'naming' in the *Timaeus* is really even greater than my list would make it appear. In a number of cases, the verb of 'naming' applies to each item in the preceding list of substances, and not only to the final item, which is the only one I have listed. For example, λέγεται properly attaches to hail, ice and snow as well as to frost (59E2-5, cf. n° 8 above). Equally, in sentences where a verb has to be supplied from the context, we are probably meant to supply a verb of naming: for example, instead of conjuring up an ἐστι or a γίγνεται to complete the account of 'hard' and 'soft' (62B6-C3), we are probably meant to repeat ἔσχεν ὄνομα, from the end of the preceding analysis (62B6). So much at least would seem to be implied by Plato's remark at the end of his account of the common *pathemata*, where he tells us that he has now rehearsed both the *pathemata* and 'the names we give to the agents which cause the *pathemata*' (65B4-6: τὰ ... παθήματα, τῶν τ' ἐπωνυμιῶν ὅσαι τοῖς δρῶσιν αὐτὰ γεγονάσι).

of oil, as one of the *eide* of water: 'it is smooth and cuts up the visual ray, and is therefore shining and sparkling to the eye' (60A5-6). Thus our naming of the character of the *eide* is simply a projection upon the agent of the effect that we experience in our own bodies.

The case is perhaps clearest in the account of temperature. Plato's point here I take to be that in speaking of ourselves as 'feeling' cold we also *speak of* whatever makes us cold as 'being' cold. Thus in the account of trembling and shivering, Plato tells us that: 'this whole *pathos* has the name of cold, as also does the agent which causes it' (62B5-6).

From this it is a natural step to our giving the same, or a similar, name to an equivalent effect exerted by the same agent upon some other object. Thus in the account of metals we are told that the removal of fire has *come to be called* 'cooling', while the process of integration consequent upon the departure of fire has likewise *come to be called* 'setting hard' or 'solidification' (59A6-8).

This process, therefore, explains the phrasing which I emphasised in my first account of the nature of the *pathemata*.¹² Whatever our flesh yields to, is hard: whatever yields to our flesh is soft (62B6-7). Plato adds, 62B7-8: πρὸς ἀλλήλα τε οὕτως. 'So things are too in relation one to the other.' The principle which we apply to our sensations is transferred to the relation between non-sentient subjects. But it is transferred only in speech. Water 'is spoken of' as fluid, and soft, 59D5-6: ὑγρὸν λέγεται, μαλακὸν τε αὖ.

(iii)

I conclude that Plato's use of terms such as 'hot' and 'cold' or 'white' in his account of the *gene* is not intended to breach the principle, common to the *Theaetetus* and the *Timaeus*, that such characters in fact arise only through the conjunction of perceived object and percipient.

On the other hand, the transference of names to the *gene* is part of an approach which is distinctive of the *Timaeus*, and which finds no obvious parallel in the *Theaetetus*.¹³

Thus in the *Timaeus* it is clear, from Plato's account of the construction of the primary solids, that within the *gene* there do not exist any constituents other than the sizes and shapes of the four primary bodies. From these, and from these alone, Plato must be able to deduce the whole variety of sensible phenomena. He must be able to explain therefore why we *feel cold*, and why we say that other things *are cold*, and *cool* things.

¹² Pp. 110-13 and 135 above.

¹³ Rather the contrary: 'naming' is disparaged in the *Theaetetus* (cf. 157B5), as suggesting a false stability.

But Plato does so, without at any point committing himself to the notion that cold or coldness exists as in any way a character or power intrinsic to the *gene*, and therefore without at any point transgressing the principles of the *Theaetetus*. For the point of Plato's system, in the *Timaeus*, is to apply to the sentient, or at least to the human, body precisely those processes which he has established as existing, and as acting, in the world at large. When we feel hot or feel cold it is because our bodies are attacked by tetrahedra or icosahedra which cut or compress our bodies in precisely the way that they would cut or compress a non-sentient substance, metal or iron.

But at this point there intervenes the feature of Plato's theory peculiar to the *Timaeus*. For when the particles cut or compress our bodies, we say not only that we feel cold or that we feel hot; 'hot' and 'cold' we therefore apply also to the agent which causes our feeling, and similar terms therefore, 'melting' and 'cooling', we apply to the action of these same agents on bodies other than our own.

But Plato's theory does not therefore allow, indeed it is designed precisely to avoid, the conclusion that 'hot' and 'cold' exist as powers or properties intrinsic to fire or to water. Plato's theory is designed to explain why we *feel* hot and cold, and why we *call* other things hot and cold, although the only things that in fact exist, as constituents of the sensible world, are the primary bodies or triangles, differing in size and in shape.

(iv)

I have deliberately glossed over several significant considerations in this chapter, in order to avoid being carried too far from the *Timaeus*, and from the subject of weight. In particular, I have deliberately restricted the analysis in this chapter to Plato's account of the regular solids as an explanation of the four elements, leaving aside Plato's parallel explanation of the elements in terms of forms and their instantiations.

For my purpose at this point is to do no more than establish the essential outline of Plato's theory of the *gene* and the *pathemata* as dependent upon his theory of the regular solids, since it is within this context that there appear the two definitions of weight, in terms of number and in terms of resistance. My excursion into the *Theaetetus* is intended to show only that the account I have given of Plato's theory in the *Timaeus* is not undermined by any central discrepancy with the theory of the *Theaetetus*. Any more particular conclusions would have to delve much more deeply into the *Theaetetus*, and also into passages from the *Republic* and the *Philebus*.

Within this very restricted frame of reference my conclusion is that while the *gene*, the *pathemata* and *aisthesis* are intimately related in Plato's theory, no one category coincides with any other.

1. The *genos* of fire is established by its identification with the tetrahedron.

2. The *pathos* or *pathema* which fire therefore produces is a cutting action.

3. When this cutting action is exerted upon a sentient body, and upon that part of a sentient body which is able to convey the movement of cutting to the 'mortal soul' or the *phronimon*, then we have the sensation of heat.

4. Within this scheme, we not only say 'I feel hot', but by a transference of terms we also say that 'the fire is called hot'; and by a further transference of terms we say that 'the fire heats and melts metal'.

Conversely, we say that 'I feel cold', that 'the water is called cold', and that metal 'is cooled' or 'solidifies'.

By these statements we do not, in Plato's system, attribute any objective 'quality' to the fire or the water. The only things that exist are the tetrahedra of fire, or the icosahedra of water, with the actions, of cutting or of compression, that are appropriate to them.

The effect of these bodies upon us, if it reaches to a conscious and sentient level, we call 'hot' or 'cold', 'hard' or 'soft', and by a transference of terms we then apply these same names to the agent of our *pathos*, and to its effect upon, or relation to, a non-sentient object, but without needing to imply thereby the existence of any quality or power within the object other than the shape and size of the primary particles.¹⁴

¹⁴ I have made no mention here of the 'traces' of the elements, as fiery or watery (*Tim.* 52Dff.). I shall suggest later (pp. 160ff.) that, within the context of the *Timaeus* as a whole, the elemental 'traces' have an historical and a didactic purpose; whether they have any more strictly functional relation with the forms or with the geometrical figures which are aligned with the elements, is a tricky question, which falls outside the scope of my present study.

The other problem I have mentioned, the apparent duplication in Plato's account of fire, for example, as dependent both upon form and upon the shape of the primary particle, the tetrahedron, is again a ticklish question, which has not been adequately treated, despite the welter of material which floods the journals on other points in Platonic scholarship. A unified explanation in terms of 'forms' and 'particles' is asserted in passing by Paul Shorey, *What Plato said* (Chicago, 1933) 340, and is vigorously defended by J. W. Yolton, 'The ontological status of sense-data in Plato's theory of perception', *The review of metaphysics* 3 (1949-50) 21-58. It is assumed, rather than proved, by G. R. Morrow, 'Plato's theory of the primary bodies in the *Timaeus* and the later doctrine of forms', *AGPh* 50 (1968) 12-28. The opposite view is defended briefly but succinctly by R. J. Mortley, 'Primary particles and secondary qualities in Plato's *Timaeus*', *Apeiron* 2 (1967) 15-17. Luc

§ 3. THE 'TWO' THEORIES

This whole framework leaves open an obvious invitation for there to be included within it the 'naming' of the pair of opposites which forms the subject of my study: heavy and light, as defined among the *gene* by number and density, and as determined, among the *pathemata* by direction and by resistance.

I need to add only one detail further: the relation of weight and movement. In the pages following the definition of fire as 'lightest' (56B1), Plato twice picks up the idea, which had been introduced before the construction of the geometrical solids, that the elements in the cosmos are separated out on the principle of like to like, and that each element therefore moves to its proper place within the cosmos, the elements which are most alike being closest together, and those which are least alike being furthest apart. Although Plato has not said so in so many words, the implication is clearly enough that fire moves to the circumference and earth to the centre, with air and water in between.¹⁵

The association of weight and movement I shall explore more fully in the next section of this chapter; for the moment, I note only that the movement of the elements, each to its 'own' place, provides the final factor needed for the conciliation of Plato's 'two' theories of weight.¹⁶

(i)

I have already quoted the judgment of Cherniss: that 'the implications drawn from the chance remark', on fire being lightest because the tetrahedron is made from the smallest number of triangles 'are definitely rejected', in Plato's later analysis of heavy and light as defined by resistance. Plato's later analysis 'is too forceful to leave any doubt that the number of planes to a corpuscle has no bearing upon the problem or its solution'.¹⁷ Solmsen follows Cherniss. Weight defined by number is not 'a clue to Plato's final conception of weight or lightness'.¹⁸

Brisson, *Le même et l'autre dans la structure ontologique du 'Timée' de Platon* (Paris, 1974) 401-5, thinks that Plato left the question open. Elsewhere, the problem is neglected. Erkkä Maula, for example, despite the title of her study, and the wide-ranging character of her introductory remarks, nowhere comes to grips with the problem, *Studies in Plato's theory of forms in the 'Timaeus'* (Helsinki, 1970).

¹⁵ The earlier reference, 52E5-53A7; repeated, 57B7-C6; 58B8-C2.

¹⁶ See pp. 159ff. below. Each to its 'own' place: Plato writes διέστηχεν ... κατὰ τόπον ἴδιον (57C2-3) and μεταφέρεται πρὸς τοὺς ἑαυτῶν τόπους (58B8). See further pp. 219ff. below.

¹⁷ *ACPl* 136-9, 161-5, cf. p. 79 above.

¹⁸ *Aristotle's system* 280 n. 19, cf. p. 79 above. Interestingly the inconsistency of the two theories, or rather the independence of the later theory, is also asserted by Simplicius, who denies that the earlier theory is part of Plato's conception, on the ground, initially, that there will be more triangles in an icosahedron of water than in a cube of earth, *De caelo* 684.1-12.

But from the analysis which I have already given there must at once be the assumption that the two theories are in fact as closely related as are soft and hard in the account of metal or water and soft and hard as measured by our flesh, or as are the heating or cooling of metals and our feeling hot or shivering with cold. In these cases we must distinguish the relevant features of the primary bodies, their size, the sharpness of their sides and angles, or the stability of their surfaces, from the effects which these bodies thereby produce upon each other, and upon a sensible percipient. Clearly, we must look for a similar distinction in the case of heavy and light.

If we do so, then the two features which link the account of the primary bodies with the analysis of weight in terms of resistance prove to be the size of the primary bodies, or more precisely the number of triangles in each of the regular solids, and their movement to different places in the universe: precisely the features which we find in Plato's earlier passage, where weight is defined by number and density, and where the elements are distributed each to its proper place in the universe.¹⁹

(ii)

Thus initially the point which we need to appreciate is that when Plato comes to describe the definition of weight by resistance, he has already explained, according to his own ways of thinking, how it is, and why it is, that the four elements should be attracted each towards its own region in the cosmos.

The point of the later theory of weight is therefore to explain the conjunction between such movements and a sensible percipient, precisely in the way that the analysis of heat and cold is intended to explain the conjunction of sharp or large particles with a sensible percipient, and precisely in the way that the analysis of hard and soft is intended to flow from, and to explain, the conjunction of the shape or the density of the primary bodies with our flesh.

Initially, therefore, what we measure, when we measure heavy and light, is, precisely as Plato tells us, the force exerted by fire or by earth in being dragged away from its own place into 'the alien air', or possibly—for the two ideas, I have suggested, are really the two sides of the same coin—the force which we must exert, or the force we feel, in seeking to keep either element from returning to its like.

But in measuring, or in 'feeling' weight, we do not measure only the direction of movement, we measure also, to speak very anachronistically, what we might perhaps call the quantity of movement. Earth moves

¹⁹ The definition of weight by resistance, 62C3-63E8; see my first two chapters.

always towards the centre. But how is it that one quantity of earth is heavier—'feels' heavier—than another?

(iii)

The answer to this question is provided by the definition of weight in terms of the number of triangles.

In Plato's earlier analysis, fire is 'lightest' because the tetrahedron has fewest triangles, while the kind of water made from large particles is 'heavy'. The same principle explains why copper is lighter than gold: the icosahedra and the cubes from which copper is made have large gaps between them, so that in any accumulation of the particles from which copper is made there are fewer triangles than in an equivalent volume of gold.²⁰

This same principle, I suggest, will in turn explain why in defining weight in terms of resistance the larger quantity of earth or of fire is heavier than a smaller quantity. The greater number of triangles in the larger quantity of earth, all seeking to return to their like, to their 'parent body', will be more difficult to drag away from the centre, or will require greater exertion on our part to keep them from returning to their like.

(iv)

This conciliation of the two theories is of course dependent upon the analysis that I gave earlier of the passage where Plato defines weight in terms of resistance. It is only with the interpretation that I gave of resistance in the earlier chapters of this essay that the 'two' theories can be reconciled, for it is only if we suppose that the larger quantity of earth or of fire is invariably the heavier that we can equate heavy and light as defined by resistance with the presence within what is heavy and light of respectively a larger and a smaller number of triangles.

On Taylor's interpretation, the larger quantity of either element is *not* invariably the heavier, for a larger quantity of either element is heavier in its own place (earth at the centre, fire at the circumference), but lighter in the 'opposite' place (fire at the centre, earth at the circumference).²¹

With this interpretation it will be impossible to join the two theories, for when fire is measured at the centre, or when earth is measured at the circumference, then the quantity of either element with the larger number of triangles will not be heavier than the quantity of the same element which has a smaller number of triangles.

²⁰ Fire as 'lightest', 56B1-2; pp. 81-2 above. Water as 'heavy', 58E2; pp. 82-3 above. Copper and gold, 59A8-C3; pp. 89-96 above.

²¹ For Taylor's interpretation see above ch. III § 1, pp. 45-50.

As it is, Plato, I have argued, either intends to speak only of earth at the centre and of fire at the circumference, where in either case the larger quantity is explicitly said to be the heavier; or else he intends to expand the scope of his theory to include fire at the centre and earth at the circumference, but in that case the terms of his final definition still require that the larger quantity of either element should be the heavier.

(v)

It is true that there remains the difficulty that in the earlier passage Plato accounts both for the comparison between different elements (fire is the lightest element) and for the comparison between different portions of what are basically the same element (the comparison of copper and gold), whereas in the later account he describes only the comparison between different portions of the same element, with no direct comparison offered between fire and earth.

To this anomaly I shall return in my concluding chapter, since it touches upon the broader issue of the sense in which Plato's account of sensation can be offered as a corrective to normal usage, and since I believe it also affords one of the starting-points from which Aristotle may be seen to have derived his own, rather different, theory of the correlation between weight and place.

For the moment, I would emphasise only that the account which Plato himself has given of weight as a *pathema* is restricted to the comparison between different quantities of the same element, and that from this point of view the *pathema* of weight is sufficiently catered for by precisely the two factors which Plato had established in the account of weight among the *gene*: the movement of an element in a particular direction, towards the centre or towards the circumference, and the number of triangles which are contained either in the individual elemental particle or in the accumulation or agglomeration of elemental particles.

(vi)

I conclude that weight associated with movement, and specifically with the direction of movement, and weight defined by number and by density, are the minimal, and the essential, factors required to explain those effects upon the body of a sensible percipient which Plato describes with such elaboration in his account of weight as defined by resistance.

Thus according to the earlier theory each element moves towards it like, while at the same time the body which has the least number of triangles is 'lightest' (56B1).

The later theory therefore, the definition of weight in terms of resistance, adds nothing to the first, the definition of weight in terms of number and of density, beyond the intervention of the sensible percipient, in precisely the same way that we feel hot, or that a stone is hard to the touch, because in either case a sensible percipient, a body, our flesh, receives the *pathema* of a body composed of geometrical solids that are sharp or unyielding.

Seen in this way, the 'two' theories of weight are essential to Plato's whole conception of the interdependence of perceived object and percipient. When Cherniss writes of Plato's earlier account of weight as a 'passing' and a 'chance' remark, and when Solmsen writes in the same context of Plato's 'divergent and conflicting attempts to cope with the problem' of weight, both scholars misunderstand not only Plato's theory of weight, but the whole conception which the *Timaeus* provides of the relation between substance and sensation.²² The 'two' theories of weight are in fact no more inconsistent than the 'two' theories of hot and cold, or hard and soft, or sweet and sour, once we understand aright Plato's conception of the primary solids, of the *pathemata* that they impose upon us, of the *aistheseis* that flow from the *pathemata*, and of the 'names' which we then give to these perceptions and to the agents which cause them.²³

§ 4. THE PRIMITIVE WORLD AND THE STRUCTURED UNIVERSE

If this interpretation is correct, then the expression of Plato's theory is peculiarly dependent upon its context.

I have tried to show this so far by describing the 'two' theories of weight, not only as complementary, each to the other, but as dependent each upon the place which it occupies in Plato's exposition. Thus weight is defined by number and by density, as part of Plato's conception of the world as dependent upon the construction of the geometrical solids. This same definition then underlies (or so I have argued) the definition of weight by resistance, where Plato's purpose is primarily to show the way in which the *sensibilia* depend upon the conjunction of perceived object and percipient. If this reconstruction is correct, then clearly Plato does not intend either theory, taken in isolation, to be regarded as his only theory, nor even as his primary theory of weight.

²² Cherniss, *ACPl* 136-9, 161-5. Solmsen, *Aristotle's system* 280 n. 19. Cf. p. 79 above.

²³ I have already noted an important anomaly in this conciliation of the 'two' theories: the lack of any comparison between different elements in Plato's account of the *pathemata*. There is also a difficulty over the question of 'names': Plato's theory of 'names' (pp. 147ff. above) does not apply to the conjunction of weight and direction in quite the way in which it applies to the other *pathemata*. This second, and relatively minor, anomaly, is pursued separately in Note 8, pp. 380-6 below.

From this point of view, we can see how very misleading it is when Solmsen, for example, writes that: 'Clearly the *Timaeus* embodies a plurality of approaches, and though' the analysis of weight in terms of resistance 'is by every criterion the most serious and sustained, there is room for the impression that the "Academy struggled in vain with the problem of weight"'.²⁴ We need only reflect a moment on the analogy with heat, to see how misguided this is. If we were called upon to give an account of Plato's explanation of heat, how could we possibly hope to choose between the identification of fire with the tetrahedron and the cutting action which the tetrahedron produces on other bodies, including sentient bodies? To describe either factor in Plato's explanation as 'more serious' than the other would betray only that Plato's whole conception of the relation between *gene* and *pathemata*, between perceived object and percipient, between the geometrical solids and the actions peculiar to them, had been radically mis-conceived.

But the truth is that even the context I have so far provided is inadequate for an account of Plato's theory as a whole. 'Heavy' and 'light' do not appear only among the *gene* nor only among the *pathemata*. Weight first appears in Plato's account of the random movements of the receptacle, before the construction of the geometrical solids. Heavy and light then again appear after the account of weight as defined by resistance, as part of Plato's attempt to demonstrate god's purpose in constructing mortal creatures and the human body.

These successive allusions to weight, I shall argue in this and in the final section of this chapter, form a consistent series: from the presence of weight in the primitive world, to weight as defined by the number of triangles in the account of the geometrical solids, to weight as measured by a sensible percipient, to heavy and light as subordinated to, or as resisting, the divine action of the demiurge. Each of these successive allusions to weight is intended to contribute to an understanding of Plato's theory; no one theory is intended to stand as a sufficient, and definitive, statement of the whole.

And from this point of view we touch upon, not merely a misinterpretation of one piece of Platonic theorising, but a mistaken understanding of the whole style and nature of Plato's exposition of his physical philosophy.

Thus so far I have charged Solmsen and Cherniss with failing to understand the conception which the *Timaeus* provides of the relation between substance and sensation. But the truth is that their error lies

²⁴ *Aristotle's system* 280 n. 19. The quotation is from Werner Jaeger, *Aristotle, fundamentals of the history of his development*, English translation, 2nd edn (Oxford, 1948) 307.

deeper than this. For whether by selecting one theory of weight as 'the most serious and sustained', or by supposing that the later of the two passages I have analysed is 'expressly devoted' to weight while the earlier passage contains only a 'chance remark' whose implications in the later passage are 'definitely rejected', Solmsen and Cherniss contract Plato's theory almost as drastically as I shall argue Aristotle and Theophrastus have done, when in the third part of my essay I turn to consider the criticisms which they have made of Plato's theory.²⁵

The ancient, as the modern, error lies, not simply in seeing inconsistency where there need be none, but in supposing that the *Timaeus* is so constructed that one single passage is to be given priority over any other in Plato's statement of his theory.

This, it is true, is how we should expect to read a modern text book of science, or possibly even a modern text book of philosophy: but it is not the way in which we would expect to read a poem or a novel; and though of course the one comparison is, from several points of view, as misleading as the other, nonetheless the similarity remains, I would suggest, in so far as Plato's successive allusions to weight in the *Timaeus* are not to be seen as random embellishments, nor as a merely literary device.

For Plato's purpose in the *Timaeus* is not to present individual pieces of cosmological theory, which can be detached, and considered in isolation, from the whole. The successive contexts which Plato supplies for the explanation of the cosmos are essential to a proper understanding of the details of physical theory which are included at each stage in Plato's exposition, and which may properly occur in more contexts than one.

In particular, the successive allusions to weight in the *Timaeus* are intended, I believe, to offer, through the deliberate replacement of one context by another, a single but complex conception of weight as tied to Plato's conception of the diversity of physical reality as a whole.

(i)

I return therefore to a point which so far I have touched upon only briefly: the association of weight and movement.²⁶

The initial association of weight with movement appears in an earlier passage of the *Timaeus*, where Plato describes the primitive world, as it might exist without the intervention of the deity. Heavy and light, as they appear in this passage, are the source from which there follows Plato's account of weight as defined by number and density, and from which in turn there flows the definition of weight in terms of resistance.

²⁵ Cherniss, *ACPI* 136-9, 161-5. Solmsen, *Aristotle's system* 280 n. 19. Cf. p. 79 above. Aristotle and Theophrastus, see esp. pp. 280-3 below.

²⁶ Pp. 153ff. above.

Thus the second part of Plato's treatise, in which there are described the works of reason as tempered by necessity, is devoted essentially to an explanation of the four Empedoclean elements.²⁷ In the preliminaries to this second part of his treatise, Plato tells us that everyone else has taken the nature and the origins of earth, air, fire and water for granted: worse, these bodies have been given a privileged position as the fundamental elements or first principles of the whole universe, despite our ignorance of what these bodies really are (48B3-C2).

The assumption which we make about these elements is that they form a cycle of change (49B7-C7). Water thickens and hardens into stones or earth, or else it melts and rarefies into wind and air. Air catches alight and turns into fire, which in turn is extinguished and thickened into air. The air then again turns into cloud and mist and water: from which there are again formed stones and earth.

With the exception perhaps of there being four elements involved—for the introduction of a fourth element, Aristotle tells us, was an innovation of Empedocles—this is a traditional way of thinking, associated especially with Anaximenes and with Heraclitus.²⁸ Plato's own immediate corrective to this view lies in his isolation of the 'receptacle of becoming', as an entity which must be added to his own earlier and simpler bifurcation of existence into forms and their instantiations, and in which, we are told, the four Empedoclean elements can exist as non-substantial reflections of the eternal forms (49C7-52D4).

However, at a stage even prior—whether logically or chronologically—to the instantiation of forms in the receptacle, there exist 'traces' or 'footprints' of the four elements, 'such as there might exist in something when god is absent from it'. Thus 'even before the heavens come into being' the receptacle is shaken by the unevenness of the powers which it contains and by their 'lack of balance', and the receptacle in turn 'shakes' the traces of the elements. This double movement has the effect that we see when corn is winnowed, and the grain is separated from the chaff. 'Things dense and heavy' accumulate in one place. 'Things rare and light' move elsewhere. On this principle, 'things that are most unlike move furthest apart', and so the way is prepared for the ultimate distribution of the elements in the cosmos in the way in which we see them now, the result of god's ordering the world 'by shapes and numbers' (εἶδεσί τε καὶ ἀριθμοῖς, cf. 52D4-53B5).

²⁷ The second part of the treatise: *Tim.* 47E-69A. For the division of the *Timaeus* into three parts, see above pp. 107-8.

²⁸ The evidence from Aristotle I have considered in *JHS* 88 (1968) 93-113, esp. 102-5. Heraclitus, fr. 31. Anaximenes: *Simpl. Phys.* 24.28-31 (DK 13A5, cf. *Dox.* 477.1-4), and Hippol. *Ref.* i 7.3 (DK 13A7).

In this last passage, we touch upon the most vital nerve in Plato's preoccupation in the *Timaeus*, and at the same time upon the point in Plato's system which perhaps most clearly marks the difference between the Platonic and later neo-Platonic and even Christian conceptions of cosmogony. For Plato, the 'world' is already prepared to become a cosmos by the appearance of some primitive and incomplete version of the four elements, and even by their distribution in space, but this 'world' cannot come to completion as a cosmos without the intervention of the divine. For Plato, this is the essential intuition in his cosmogony: the point which is of greatest importance to him, and the point of which he is most sure. But for those who later shared some form of this idealism it seemed that Plato had not gone far enough: without the intervention of god or soul, matter could not present even traces of the elements. There would be nothing but inchoate matter or darkness, or, for the Christians, sheer non-existence.

In order to follow precisely Plato's preoccupation, we need to keep both points in mind: the intervention of the deity as well as the existence of primitive versions of the elements, and their tendency to accumulate, like with like.

(ii)

I apologise to those readers for whom the substance of the preceding paragraphs will have been tediously familiar. I have dwelt on Plato's account of the primitive world in this way, because it is not I think usually appreciated, or at least not sufficiently appreciated, how closely Plato intends to relate the features of the primitive world that I have isolated with the results of his analysis of the four geometrical solids.

When god intervenes to order the primitive representations of the elements 'by shapes and numbers', the way in which he does so is evidently intended to correspond to the construction of the regular solids, which I have already outlined.²⁹

At the end of this analysis, Plato returns to precisely those points at which he had left the world before the intervention of the deity: the apparent mutual transformation of the elements, their distribution among the cosmos on the principle of like to like—and the distinction of heavy and light.³⁰

Thus the 'shapes and numbers' of the regular solids—if we may so conflate Plato's two formulae—are used to explain how it is that the

²⁹ 'Shapes and numbers', 53B5. The construction of the regular solids, 53C4ff. Cf. pp. 80ff. above.

³⁰ Apparent transformation of the elements, 49B7-C7. 'Like to like', 52D4-53B5. Heavy and light, 53A1-2.

elements are broken down into their component triangles and can be reconstituted, and how, in this process, three of the elements are mutually transformable.³¹

At the end of this account, Plato re-states, on the new and as it were 'scientific' foundation of his theory of the geometrical solids, the point that the elements are thereby distributed each to its own place within the cosmos. They move as they do, because of the 'shaking' or disturbance that results from their transformation, and in response to the force of attraction of like for like. The thought and the language repeat closely the thought and the language of the earlier passage.³²

Immediately prior to the two passages which describe the transformation of the elements, there is found Plato's definition of weight by number.³³ I take Plato's intention to be that this analysis of weight should act as an explanation, and as an elaboration, of the presence of weight in the primitive world, in the same way that the transformation and the distribution of the elements in the later passages are evidently intended as an explanation, and an elaboration, of the 'cycle of change', and of the 'winnowing' of the primitive traces of the elements, before the intervention of the deity.³⁴

It is perhaps even possible that the later refinement of the same theory, the explanation of weight in terms of density, is intended to reproduce, in Plato's new and more rational setting, the earlier double disjunction, in the primitive world, between things 'heavy and dense' and things 'light and rare'.³⁵

(iii)

In particular, it is this association of ideas—the presence of weight in the primitive world, and in the structured universe the explanation of weight in terms of the number of triangles and the density of the

³¹ 'Shapes and numbers', 53B5. Regular solids, 53C4ff. Transformation of the elements, 56C8-57C6, cf. 57D7-58C4.

³² The earlier passage, 52D4-53B5. The later passage, 57B7-C6.

³³ Transformation of the elements, 56C8-57C6, 57D7-58C4. Definition of weight by number, 55D6-56C7.

³⁴ The two accounts of weight, 53A1-2, 55D6-56C7. The 'cycle of change', 49B7-C7. 'Traces' of the elements, 52D4-53B5. Winnowing, 52E4ff. The later explanation of the transformation of the elements, 56C8-57C6, 57D7-58C4.

³⁵ 'Heavy and dense', 'light and rare', 53A1-2. Later explanation of density, the comparison of copper and gold, 59A8-C3. The principal parallels proposed in this section are as follows. (1) The primitive world, 47E5ff.; (2) the 'cycle of change', 49B7-C7; (3) 'like to like', 52D4-53B5; (4) weight, 53A1-2. (1) God's ordering the world by 'shapes and numbers', 53B5, i.e. the construction of the geometrical solids, 53C4ff.; (2) the transformations of the geometrical solids, 56C8-57C6, 57D7-58C4; (3) 'like to like', 57B7-C6; (4) weight, 55D6-56C7, 59A8-C3.

geometrical solids to which the elements correspond—which explains, I suggest, the conjunction, in both worlds, of weight and mobility.

Thus in Plato's account of the primitive world, weight and movement are directly related, in the sense that differences of weight and of density are singled out as the two primary criteria of unlikeness by which things move each to a separate place, 52E7-53A2: ... σείόμενα καὶ ἀνιχνώμενα τὰ μὲν πυκνὰ καὶ βαρέα ἄλλη, τὰ δὲ μανὰ καὶ κοῦφα εἰς ἑτέραν ἵζει φερόμενα ἔδραν.

Admittedly, this is a conjunction of ideas that is necessarily imposed upon Plato by his adopting the metaphor, or probably rather the example, of chaff being winnowed from the grain. Nonetheless, the conjunction of ideas is probably not accidental. For it will probably explain why it is that in what I have called the structured universe (53C4ff.) Plato is able to take for granted that air and fire move towards the circumference, while heavy things, earth and water, accumulate at the centre.

The point will be, quite simply, that this was in fact the way in which the elements had traditionally been 'sorted out' in a cosmogony. Plato's account of the structured universe is intended to retain these primitive associations, but on a new and as it were rational footing. Weight—but now weight defined by number—will be intended as one of the features by which elements are attracted 'to the place occupied by the bodies to which they are most akin', and by which in fact light things move to the circumference and heavy things to the centre, 57C4-6: ... φέρεται διὰ τὸν σεισμὸν πρὸς τὸν ἐκείνων οἷς ἂν ὁμοιωθῇ τόπον.

(iv)

At the same time, this distribution of elements is also, I suspect, intended to be a consequence of the differences in mobility that Plato has attributed to the elements, in his description of how the four geometrical solids are aligned with the four cosmic elements.

The cube is the most stable of the regular solids, and therefore corresponds to earth, the least mobile of the four elements. Of the three transformable elements, fire is the most mobile, and water the least mobile.³⁶

In the subsequent distribution of the elements, the assumption is fairly obviously that fire, the most mobile element, is sent to the circumference, where movement is greatest, while earth and water accumulate at the centre, where movement is least.³⁷

Thus the distribution of elements, in the structured universe, is a direct consequence of Plato's conception of the primary geometrical

³⁶ The cube, 55D8-56A1. Fire and water, 56A1ff., esp. 56A1-3.

³⁷ Esp. 57B7-C6, 58B8-C2; cf. p. 153 above.

solids. Fire is the most mobile element, because the tetrahedron has the fewest 'faces' or 'bases', and it is also the sharpest figure. Water is the least mobile of the three transformable elements, presumably because it has the largest number of 'faces' to stand on. Earth is the least mobile of all, because the cube is hardest to move.³⁸

In this way, the traditional association, whereby the heavier and less mobile elements accumulate at the centre of the cosmos, while the lightest and the most mobile bodies are found at the circumference, is preserved in Plato's account of the structured universe. For weight and movement are directly associated in Plato's account of the geometrical solids. Weight is a consequence of the number of elemental triangles in each solid figure; mobility is a consequence of the size and shape of the geometrical solids.

(v)

I summarise. Plato's account of the workings of necessity is divided between an account of the 'traces' or 'footprints' of the elements in a primitive world, deprived of the intervention of the deity, and an account of the structured universe, where the four Empedoclean elements are correlated with four primary geometrical solids.

The 'shapes and numbers' of the geometrical solids explain in what way the elements can be transformed into each other (with the exception of earth). The distribution, each to a different place, of things 'heavy and dense' and things 'light and rare', in the primitive world, is explained in the structured universe by the correlation of weight and mobility respectively with the number of elemental triangles and with the shapes and 'faces' of the geometrical solids.

Weight defined by the number of elemental triangles, coupled with the movement of the two extreme elements each to its own place, i.e. to the centre and to the circumference of the universe respectively, are precisely the two features that are needed to provide what I earlier called the 'ob-

³⁸ The statement that, of the three transformable elements, water is *δυσκίνητότατον* (56A2) need not conflict with subsequent claims for the mobility of water (58D4ff.). For in the later passage Plato claims only (1) that 'liquid' water is more mobile than the 'fusible' variety (58D5-E2), and (2) that the rolling movement of icosahedra makes 'liquid' water more mobile than earth (59D4-7; for both points, see pp. 110-11 above). In this later passage, therefore, there is no direct comparison of water with fire or air.

But the truth is rather that Plato has two different conceptions of 'mobility'. Fire is most mobile, because, being the 'sharpest' element, it can most easily cut its way through whatever particles find themselves in its path (this I take to be the implication at 56A7-B1: *εὐκίνητότατον ... τμητικώτατόν τε καὶ ὀξύτατον ὃν πάντη πάντων*). The icosahedra are mobile because of their 'rolling' movement (*cf. κυλινδούμενον*, 59D5). The existence of two kinds of mobility, appropriate to pointed and to spherical particles, can probably be paralleled in the Atomist system: *cf. vol. i* pp. 319-22.

jective correlate' for Plato's later account of weight as defined by resistance.³⁹ The point now to appreciate is that the conjunction of those two features has been established not only in Plato's account of the geometrical solids: that account is itself intended as a rationalisation of the movement of things 'heavy and dense' and things 'light and rare' in the metaphor which Plato uses to describe the 'shaking' of the receptacle in his account of the primitive world as it would have existed, or as it did exist, before god intervened to order the universe 'by shapes and numbers'.⁴⁰

§ 5. WEIGHT AND THE POWERS OF REASON

In the third and final part of his treatise, which describes the powers of reason in the persuasion of necessity, Plato returns to the living creatures, which at the end of the first part of his treatise he had left being buffeted and tossed from place to place, redeemed—if that is not too perverse an expression—only by the implanting of the highest part of soul in the human head, and in particular by the addition of the faculty of sight, which enables us to contemplate the supreme expression of divine order in the cosmos: the heavens and the heavenly bodies.⁴¹

It is, I think, perhaps a trifle out of focus to describe the intervening part of Plato's treatise simply as 'what comes about of necessity', as Cornford does, for the truth is that it is only the description of what I

³⁹ Cf. p. 105 above.

⁴⁰ The second part of the *Timaeus*, 47E3ff. The primitive world, with 'traces' of the elements, 52D4-53B5. God's intervention by 'shapes and numbers', 53B4-C3. The structured universe and the geometrical solids, 53C4-58C4. The two accounts of weight: in the primitive world, 53A1-2; in the structured universe, 55D6-56C7, cf. 59A8-C3.

I have taken Plato's successive allusions to heavy and light to be paralleled by the successive allusions to a cycle of change (49B7-C7) and the transformation of the elements (56C8-57C6 and 57D7-58C4). Cherniss' reaction is just the opposite: he takes Plato to be inconsistent on *both* counts. Thus by way of analogy to the supposed discrepancy between Plato's two theories of weight, Cherniss, *ACPI* 139 n. 85, parades the inconsistency whereby at 49B7-C7 earth is *included* in the cycle of change, whereas in the construction of what I have called the ordered universe, 53C4ff., the cubes of earth are not made up from the same triangles as the other regular solids, so that earth is *excluded* from the transformation of the elements. But in fact Plato makes it clear that, on this point, his later account is intended as a correction of the traditional view. As Cherniss himself later recognises (*ACPI* 150 n. 90), Plato's account of the primitive world deliberately marks out the cycle of change as a traditional belief (cf. ὡς δοχοῦμεν, 49B8), restricted to appearance (ὡς φαίνεται, C7). When he arrives at the equivalent point in his construction of the geometrical solids, Plato specifically *denies* that things are as they appear to be: ἐφαίνετο ... οὐκ ὁρθῶς φανταζόμενα (54B6-8) is surely intended as a deliberate correction of ὡς φαίνεται at 49C7. (Aristotle plays on the same word, φαίνεσθαι, used three times in his criticism of precisely this feature of Plato's theory, *De caelo* iii 7, 306a1-7.) Plato's *deliberate* correction confirms the relation I have sought to establish between the primitive world (47E5ff.) and the structured universe (53C4ff.).

⁴¹ The three divisions: 27D-47E, 47E-69A, 69Aff. Cf. pp. 107-8 above.

have called the primitive world which in fact presents us with a condition of existence wholly deprived of the divine. The organisation of the world 'by shapes and numbers' is specifically introduced as the work of the deity (53B1ff.), and the whole account of the construction of the geometrical solids, and of their correlation with the elements, is intended to represent as it were the first level of god's impingement upon the world. I have therefore preferred to describe the central portion of Plato's treatise as devoted to the products of necessity already guided by reason.⁴²

This perspective explains why in the proem to the third part of Plato's treatise we find that the materials for god's fashioning of living creatures already lie 'sorted and ready for use' (διωλισμένα, 69A7).

It is perhaps impossible to tell precisely what image Plato's unusual combination of words (τέκτοσιν ... διωλισμένα, 69A6-7) is intended to convey in this context. But the meaning may be, I fancy, not simply that the building materials are 'filtered' and so sorted by size, but that they are also shaped and ready for use, and now need only to be put together in the best possible combination. This is perhaps sufficiently conveyed by a word which elsewhere is used for filtering or straining things, and so for sorting them by size, since it is the sizes or 'symmetries' (69B4) which have chiefly determined the construction of the geometrical solids, and their correlation with the elements.

However that may be, Plato's point is that the elements are no longer the mere 'traces' of the elements that had been described, in the primitive world, as shaken and shifting to and fro, aimlessly and confusedly. The construction and the interrelation of the elements have been placed on a rational footing, in the whole account which Plato has given of the *gene* and the *pathemata* as determined by the sizes and shapes of the geometrical solids, and their correlation with the elements.

The purpose of the final part of the *Timaeus* is to explain how the *gene* and the *pathemata* are combined in the human frame, so as best to subserve the interests of soul, both mortal and divine.

In this account, heavy and light reappear a couple of times among the materials that lie 'sorted and ready' for god's use.

⁴² Cf. p. 107 above, and Cornford, *Cosmology* 159. I hope that my criticism of Cornford is not too captious. The phrase, 'What comes about of necessity', which Cornford uses as a title for the whole of the second part of the *Timaeus* (47E3-69A5), is of course only a translation of Plato's own expressions (τὰ δι' ἀνάγκης γινόμενα, 47E4-5; cf. πεφυκότα ἐξ ἀνάγκης, 68E1). My point is simply that there is a definite break at 53B1 between the world as it was, or would have been, in the absence of god, and god's (subsequent) ordering of the cosmos 'by shapes and numbers'. Cornford's equation (*Cosmology* 159-60) of 'Necessity' and the 'Errant Cause' will be true, for example, only of the first part of this analysis (47E3-53B1); the construction of the geometrical solids (53C4ff.) is not only, if at all, a product of the 'Errant Cause'.

(i)

A neat example of the new orientation of interest is provided by a comparison between the role of lightness in pungent flavours, in the *second* part of Plato's treatise, and the role of lightness in the growth of hair on the head, in the *third* part of the treatise.

Certain flavours—such as mustard, we may suppose—join with the hot substances in the mouth, and are heated by them, and heat them in return. They then 'rise to the senses in the head because of their lightness', cutting into whatever they meet with on the way, and so producing a pungent effect. So much Plato tells us in the second part of his treatise (65E4-66A2).

The same phenomenon, the rising of fiery particles through the head, is utilised in the third part of Plato's treatise to solve perhaps the most famous example of the potential conflict between the purposes of reason and the powers of necessity.

The head needs to be protected, but if it is given a covering of flesh its sensitivity will be decreased. The gods are therefore faced with a dilemma. They can choose a life 'double, and more than double' the length of our present span, 'healthier and less painful', but also less intelligent. Alternatively, they can choose a more intelligent life, but also a shorter and a more painful one. The two claims, between an intelligent life and a long and painless one, cannot be reconciled (74A7-75B7).

The gods choose to sacrifice health and longevity to sensitivity, but the harsh consequences of their choice are mitigated by the growth of hair. First of all, the skull is covered with skin. Then the deity pricks our scalp all over with tiny perforations. Through these tiny holes there percolate pure moisture and pure heat, carrying with them quantities of the same substances that formed the skin. The moisture and heat make their escape, but as they do so their movement away from the body elongates the other ingredients that are carried with them, so as eventually to form a covering of hair (75B7-76C5).

Because hair is 'light', we are told, it is a more suitable covering for the head than flesh would have been. It provides sufficient protection from the heat of summer and the cold of winter, and yet it does so without obstructing the clarity of our perception, in the way that flesh—which is obviously intended to be heavier—would have done (76C5-D3).

(ii)

The final allusion to weight in the *Timaeus*—if we omit 'sharp' and 'heavy' used for what we would call high and low notes in music (80A3)—occurs as the culmination of a series of passages where the

behaviour of elements in the body is compared, quite elaborately, to the behaviour of elements in the cosmos at large.

I have already touched upon the transformation and distribution of elements in the cosmos.⁴³ Since there can be no empty space, Plato tells us, there is a kind of compression exerted by the outermost circuit of the heavens upon the elements that lie within. The tetrahedra of fire, being the finest or smallest bodies, are forced by this pressure into the interstices between the larger solids, 'and so also the other elements in order'. Two processes can then result. The smaller elements can break down the larger bodies, so that air or water turns into fire. Alternatively, the larger elements compress the smaller ones, so that the triangles of fire are rearranged as air or water. In either case, the change of size, and of kind, entails a change of place, and in this way movement within the universe continues endlessly (58A4-C4).

Similar principles explain the rather complicated processes of breathing (77C6-79E9). In this case, the different sizes of the elements allow the gods to construct a cage of air and fire, which can keep the particles of water and earth within the body, while allowing free entry and egress to particles of fire and air. Since—again—there can be no void, movement of air and fire out of the nostrils must force other particles of air and fire, which are clustering outside the body, into the lungs and chest through the skin. In this way, a swaying movement is established, as the particles from the mouth and nostrils force air and fire through the skin of the chest, while the departure of air and fire from the chest forces other particles into the body again, through the nose and mouth. The whole process is maintained by the tendency of fire to seek its like. The particles of air are heated by the fire around the heart, and are thereby driven out of the body to seek their like, and it is by this movement that cool air is displaced, and forced into the body again.⁴⁴

The process of breathing accounts for the distribution throughout the body of nourishment, since the movement of air and fire carries with it the movement of blood. This latter process is compared directly to 'the movement of the whole', 81A2-B4:

'The manner of this replenishment and withdrawal follows the same course as the movement of each individual body within the universe, whereby each thing of the same kind is carried towards its like.

'To start with, there are the particles that surround us from without, and that are constantly eroding our bodies, and dividing us into pieces, dispatching every part to join its own kind.

⁴³ Pp. 88-9, 153 and 159ff. above.

⁴⁴ For the Empedoclean background to Plato's theory of breathing, see my study, 'The effect of a simile: Empedocles' theories of seeing and breathing', *JHS* 90 (1970) 140-79, esp. 171-3.

'Then there are the particles of blood that are chopped up into small pieces inside us. These are held within the body, as they might be within a universe created to contain them, and they are forced thereby to imitate the movement of the actual universe.

'Thus each of the particles that is broken down into small pieces inside us is carried towards its like, and subsequently causes the space that has been left vacant to be filled up again.'

All goes well, so long as this process can be sustained. When the triangles grow old and flabby, they can no longer convert the nourishment that enters the body to their own kind. And when eventually the triangles in the marrow can no longer hold the soul together, death intervenes (81B4-E5).

Alternatively, there may be a predominance or deficiency of one element, or the elements may be displaced, and may occupy a region other than their own. This is the origin of illness.

'For when any element arises contrary to nature, and occupies a place other than its own, then things that were cool before grow hot; things that were dry grow moist and are dry no longer; so too with things light; so too with things heavy: change is rampant everywhere' (82A7-B2).

(iii)

I conclude that, if we pay careful attention to the deliberate progress of thought throughout the three main parts of the *Timaeus*, Plato's repeated allusions to weight are seen to form part of a continuous and consistent scheme.

Heavy and light, and rare and dense, are first introduced as part of a traditional pairing of opposites, within Plato's account of the primitive world: the world as it would be 'in the absence of god' or the world as it would be—in the language of the *Politicus*—if it were wholly to forget 'the teachings of the father'.⁴⁵

Initially, Plato's purpose, in the central portion of his treatise, is to rationalise the random movements of these 'traces' of the elements, by correlating the four traditional elements with the four primary regular solids. The primitive world is thus supplanted by a structured universe, where the transformation of the elements and their distribution throughout the cosmos is explained in terms of the sizes and shapes of the regular solids. Within this new account, heavy and light are defined by the number of triangles in each solid, so that fire is the 'lightest' body and water is 'heavy'. Thus weight and mobility are explained respectively by the number of triangles in the primary solids, and by their shapes and sizes.

⁴⁵ Cf. *Pol.* 273B2, C6.

These two features underly Plato's account of weight in his analysis of the *pathemata* in the same way that the shapes and sizes of the elemental particles underly, and determine, our perception of hot and cold, hard and soft, sweet and sour. In each case the *pathemata* which our body experiences, as a result of the impingement upon it of the elemental particles, are liable, if the particles hit upon a part of our body which is sufficiently sensitive, to be transmitted to the 'mortal soul', where they will be registered as sensations, differentiated by their transmission through flesh and the various parts of our body that are designed for their reception.

Thus in the case of weight, we 'feel' heavy and light in the difference of effort required to remove a large or a smaller quantity of earth from its parent body, or possibly in the difference of effort required to keep different quantities of earth, or of fire, from returning to their parent body: in either case, we measure, in effect, the number of elemental triangles and the tendency of either body to return to its native element.

When god has organised the materials of the universe 'by shapes and by numbers', he is able to return, in the third part of Plato's treatise, to the work of fashioning living creatures, in the best way that the materials at his disposal will allow him.

Thus the movement of fire to the head, which had been employed without any teleological overtones to explain pungent flavours, is now put to work to explain the formation of hair, as an alternative covering for the skull to flesh, a 'light' covering which will not impair our sensitivity.

Similarly, the principles which Plato introduced as governing the movement and behaviour of elements in the cosmos are now employed to explain the bodily processes, breathing and digestion, which subserve the purposes of mortal soul. Only in disease do 'hot and cold and wet and dry and heavy and light' fail to keep to their proper places.

The allusions to heavy and light in these later parts of the *Timaeus*, if they were taken in isolation, could perhaps be understood in a merely conventional sense. But as it is, in the context of the *Timaeus* seen as a whole, they are, it seems to me, fairly clearly intended as a continuation of the 'mathematical' explanation of weight, in terms of number, which Plato has supplied as a deliberate corrective to the traditional understanding of heavy and light, and up and down.

Heavy and light in the primitive world, heavy and light as defined by the number of triangles, heavy and light in relation to the human percipient, and finally the allusions to heavy and light in the third and last part of the *Timaeus*, all have their place in what Plato evidently intends to be a clear and consistent nexus of ideas supporting, and illuminating, the

dominant conception of his physical philosophy: the work of god in bringing harmony and order to a world which he did not make, and where the powers of reason exploit to the full, but do not wholly eradicate, the forces of necessity.⁴⁶

⁴⁶ For the three parts of the *Timaeus*, see above pp. 107-8. The successive allusions to weight are as follows. Part two, in the primitive world: heavy and light, dense and rare, 52D4-53B5. Part two, in the structured universe: weight defined by number among the *gene*, 55D8ff. (fire is 'lightest'), 58E2 (water), 59A8ff. (copper and gold), 60C3 (air); heavy and light among the *pathemata*, 62C3-63E8; pungent flavours ('mustard'), 65E4-66A2. Part three: hair, 76C5-D3; illness, 82A7-B2.

PART THREE

CRITICISM AND INTERPRETATION

CHAPTER NINE

ARISTOTLE ON PLATO

§ 1. A NEW APPROACH

I have already had recourse to Aristotle for the reconstruction of one feature of Plato's theory: the reduction of triangles of different sizes to elemental particles that will be all of the same size.¹ Aristotle's evidence is no less important as confirmation of the more general conclusion I have now come to: the conciliation of Plato's two theories of weight, as determined by number and by density, and as defined by direction and by resistance. For only if we adopt the conciliation that I have offered of Plato's 'two' theories can we begin to understand the nature of the critique which Aristotle applies to Plato's theory of weight.

Admittedly, in writing in this way, there is an element of circularity, which I have not tried to remove. The conciliation which I have offered of Plato's two theories is an indispensable prerequisite, it seems to me, for our understanding of Aristotle's criticism of Plato. At the same time, the fact that Aristotle's criticism of Plato can be understood on these terms is an argument in favour of the conciliation that I have offered. Strictly, therefore, we could perhaps start from either point: the conciliation of the two theories, or the nature of Aristotle's criticism. But in either case we should want to end up with an interpretation that would make sense at once of Plato's theory and of the criticism which Aristotle makes of it, whichever direction we had started from.

As it is, there are two features which I have sought to oppose in the interpretations that have been offered hitherto of Plato's theory of weight.

1. In Plato's later definition of weight, according to Taylor, fire is lighter than earth at the centre but heavier than earth at the circumference, while a larger quantity of fire or of earth is heavier than a smaller quantity in its 'own' place, but lighter in the place which is opposite to it.²

2. According to Solmsen and Cherniss, the earlier definition of weight is a casual, and a trivial, addition to Plato's theory.³

¹ Pp. 85-7 above.

² Taylor, *Commentary* 440-1; see esp. pp. 45ff. above.

³ Solmsen, *Aristotle's system* 280 n. 19. Cherniss, *ACPl* 136-9, 161-5. See esp. p. 79 above.

These two features are connected. As I have shown, if we adopt Taylor's interpretation, whereby either element, and a larger quantity of either element, can be the lighter, then it is impossible for Plato's later account of weight, as defined by resistance, to be reconciled with the earlier analysis, where a body with the larger number of triangles is necessarily the heavier.⁴

This is in fact, as I shall show, the line of thinking that fairly obviously has been adopted by Cherniss. My purpose in the opening section of this chapter will be therefore to consider briefly the consequences for Aristotle of the interpretation which Cherniss has adopted of Plato's 'two' theories of weight.

In the subsequent sections of the chapter, I shall then take for granted the conciliation that I have offered of Plato's two theories, and in the light of this conciliation I shall attempt to elucidate the assumption and the principles which in fact, I believe, govern Aristotle's critique of Plato.

(i)

In the third book of the *De caelo*, in the course of a long series of criticisms directed against Plato's attempt to construct the material world from surfaces, Aristotle includes in his attack the 'definition' of weight in the *Timaeus*, whereby 'bodies are heavier depending upon the number of surfaces they contain' (iii 1, 299b31-300a1).⁵

Aristotle returns to the subject in more detail, in the preliminaries to his own analysis of heavy and light in book four of the *De caelo*. He tells us here (iv 2, 308b3-12) that, for those who explain heavy and light according to the written theory of the *Timaeus*, weight varies in direct proportion to size or number: a heavier body has a larger number of like constituents—which later in the same passage Aristotle writes of specifically as triangles (308b15)—and a lighter body has less. On this principle, Aristotle tells us, the Platonists attempt to explain differences of weight both between different quantities of bodies of the same kind (lead or copper) and also between bodies of different kinds (lead and wood).

Such a theory, Aristotle objects (308b12-21), cannot explain the differences between earth and fire. For on this theory, Aristotle argues, a larger quantity of fire will be heavier than a smaller quantity, whereas in fact—i.e. on Aristotle's own theory—it is lighter.⁶

⁴ Cf. pp. 155-6 above.

⁵ The whole series of criticisms begins, iii 1, 298b33. For my interpretation of the criticism of weight (299b31-300a7), see below pp. 193-6.

⁶ The second passage (308b12-21) is transcribed and paraphrased below, pp. 199-200. For both passages, cf. pp. 85-7 above.

In the earlier part of this passage, Aristotle writes as follows, iv 2, 308b3-12: λέγουσι γὰρ τὸ κουφότερον καὶ βαρύτερον οἱ μὲν ὥσπερ ἐν τῷ Τιμαίῳ τυγχάνει γεγραμμένον, βαρύτερον μὲν τὸ ἐκ πλειόνων τῶν αὐτῶν συνεστός, κουφότερον δὲ τὸ ἐξ ἐλαττόνων, ὥσπερ μολίβδου μόλιβδος ὁ πλείων βαρύτερος καὶ χαλκοῦ χαλκός. ὁμοίως δὲ καὶ τῶν ἄλλων τῶν ὁμοειδῶν ἕκαστον· ἐν ὑπεροχῇ γὰρ τῶν ἴσων μορίων βαρύτερον ἕκαστόν ἐστιν. τὸν αὐτὸν δὲ τρόπον καὶ ξύλου μόλιβδόν φασιν. ἔκ τινων γὰρ τῶν αὐτῶν εἶναι πάντα τὰ σώματα καὶ μιᾶς ὕλης, ἀλλ' οὐ δοκεῖν.

I paraphrase:

'Some people explain what is heavier and what is lighter in the way that may be found set out in the *Timaeus*.

'<On this view,> the body which is made out of a larger number of the same <parts> is heavier, and the body made out of a smaller number <of the same parts> is lighter, in just the way that a larger piece of lead is heavier than a <smaller> piece, and a <larger> piece of copper heavier than a <smaller> piece.

'The same is true <or so they say> for <any and> every one of <all> other bodies that are made from <constituents> of one and the same kind: every <such body> is more heavy <or less so> in virtue of <its having> a preponderance <or deficiency> of parts that equal.

'The same explanation they claim to extend <to bodies that are different in kind, for example> to lead <being heavier> than wood.

'For <on their theory> all bodies are made from certain <elements that are> the same <for everything>, in effect <therefore> from a single material principle, despite the fact that they do not look as though they were.

'<A piece of lead is heavier than a piece of wood therefore because it contains a larger number of identical elements.>''

(ii)

Cherniss rightly recognises that in this passage, as in the passage from book three, Aristotle adopts the theory of weight as defined by number, which appears in the earlier part of the *Timaeus*, in the course of Plato's account of the primary geometrical solids and their correlation with the elements. He writes of the passage from book three:

'It is remarkable that Aristotle in his representation of the theory of the *Timaeus* appeals to a passing remark in a section not concerned with the problem of weight (which is treated later in the dialogue) and does not mention the passage expressly devoted to that question ... where the implications drawn from the chance remark are definitely rejected.'⁸

⁷ For Stocks' misinterpretation of the distribution of ideas in this passage, see Note 4, esp. pp. 353ff.

⁸ *ACPI* 138-9. Cherniss writes in the same vein of the passage from book four, *ACPI* 162: 'It is remarkable that Aristotle ... pays no attention to the theory of relative weight worked out in this section. of the *Timaeus* [i.e. in the account of the *pathemata*] but instead

In writing thus, Cherniss is as much blinded by his prejudice against Aristotle as he is in his treatment of Aristotle's evidence for Democritus. Cherniss simply does not pause to consider that Aristotle's apparent willingness to rely in his criticism on Plato's earlier theory, of weight as determined by number, might well be an indication that this theory is not a 'passing' and a 'chance remark'.

Equally, Cherniss does not allow himself to reflect that the fact that Aristotle does not repeat the analysis of weight as determined by resistance might be an indication that he sees no need to differentiate between the two theories: that Aristotle's behaviour might in fact indicate that the two theories were taken by him, and might even therefore possibly have been intended by Plato, to be two facets of a single explanation of weight.

(iii)

The more general reason for Cherniss' blindness at this point lies in his persistent and habitual denigration, to a quite excessive degree, of Aristotle's abilities to comprehend or to report on the theories of his predecessors. However, the more particular reason lies in Cherniss' acceptance—albeit unacknowledged, and perhaps even unconscious—of Taylor's interpretation of the *Timaeus*.

Cherniss writes that:

'Aristotle, in the dilemma with which he presents Plato, tacitly assumes his own doctrine of an absolute weight (or lightness) which inheres as a quality in each of the simple bodies; he does not note that this is expressly denied by Plato, *who says that the body which is heavy in one region of the universe is light in another* and explains weight as a relationship between a given body and the environment in which it happens to be.'⁹

I have italicised the phrase where Cherniss introduces the thesis which Taylor attributes to Plato: but falsely so.

Plato's explicit statement, in his definition of weight by resistance, is limited to the measurement of fire at the circumference and of earth at the centre. There is no mention, in Plato's text, of the converse circumstance, of fire measured at the centre, or of earth measured at the

gives as the theory of the *Timaeus* the notion that weight varies directly with the number of the constituent triangles.' He concludes, *ACPl* 165: 'The complete neglect of what is expressly given in the *Timaeus* as the explanation of weight and the substitution for it of a theory constructed from a single passing remark show not only the invalidity of the arguments in refutation but also the untrustworthiness of Aristotle's presentation of Platonic doctrine.'

⁹ *ACPl* 139.

circumference. There is therefore no claim, by Plato, that 'the body which is heavy in one region of the universe is light in another'.¹⁰

(iv)

Cherniss' tacit, and perhaps unconscious, adoption of Taylor's interpretation has disastrous consequences. He writes:

'In *our* region of the universe it so happens that fire, which has the fewest plane surfaces to its corpuscles, is lightest; and, since Plato cannot stop here to bring in the dissertation on the relativity of direction and of weight, he mentions this coincidence in passing. He does not say that it is the explanation of the phenomenon of weight; and, when he comes to discuss the matter for itself, *Timaeus* 63D-E is too forceful to leave any doubt that the number of planes to a corpuscle has no bearing upon the problem or its solution.'¹¹

Why does Cherniss suppose that 'the number of planes to a corpuscle' can have 'no bearing upon the problem or its solution'?

Because he has adopted Taylor's interpretation of the later theory. On Taylor's interpretation, earth is heavier than fire at the centre, but lighter than fire at the circumference.

Thus on Taylor's interpretation there follows the contradiction that:

1. If weight is defined by number, then an element must have a fixed weight, whatever its position.
2. But on Taylor's interpretation of Plato's later theory, no element has a fixed weight, for what is light in one place is heavy elsewhere.

Plato's two theories of weight are therefore impossible to reconcile. 'The number of planes to a corpuscle' can therefore have 'no bearing upon the problem' of weight 'or its solution.'

¹⁰ The formula I have italicised ('the body which is heavy in one region of the universe is light in another') is ambiguous. Cherniss does not distinguish clearly between (1) the comparison of different elements, and (2) the comparison between different portions of the same element.

The ambiguity is relevant to whether or not we suppose Cherniss to have been influenced directly by Taylor. The comparison between different quantities of fire at the centre and between different quantities of earth at the circumference is distinctive of Taylor's interpretation, but does not appear clearly in Cherniss' account. The comparison between different elements at centre and at circumference is the only feature which appears explicitly in the continuation of Cherniss' account, and this feature could have been taken over from Martin or from any one of a number of subsequent writers. Whether Cherniss has been influenced directly by Taylor, or whether he has drawn his interpretation of the *Timaeus* from Martin, or from the subsequent literature, is of course incidental to the substance of my criticisms. See further Note 3, pp. 327ff., esp. pp. 331-4 below.

¹¹ *ACPl* 139 n. 85.

(v)

There is, however, a curious contradiction in Cherniss' account. Having declared Plato's earlier definition to be wholly irrelevant to the later theory, Cherniss in fact seems to want to reconcile the two. This at least would seem to be the purpose of Cherniss' claim, in the passage I have quoted, that the fire which is said to be lightest, in virtue of having the fewest number of 'planes', is fire which is measured at the centre.

The point of this restriction is apparently that, on Taylor's interpretation, fire is lighter than earth at the centre and heavier than earth at the circumference. By restricting Plato's description of fire as 'lightest' to fire which is measured at the *centre*, Cherniss apparently wishes to leave open the possibility that, measured at the *circumference*, fire would be heavier than earth.

But in adopting this interpretation, Cherniss runs into a string of difficulties.

1. Plato gives no indication that the definition of weight by number, in his account of the geometrical solids (55D6ff.), is intended to apply only to elements as measured at the centre. On the contrary, Plato's account, in the passage immediately following (56C8-58C4), of the transformation of the elements, and of their distribution, each to its own place within the cosmos, would seem to preclude any such restriction.

2. Secondly, in this attempted conciliation of the two theories, Cherniss has to single out precisely those features in Taylor's interpretation of the later theory which have no place in the text of the *Timaeus*: the comparison between different elements, and the measurement of fire at the centre.

3. Finally, Cherniss is faced with the uncomfortable conclusion that in the passage cited at the beginning of this chapter (*De caelo* iv 2, 308b12-21) Aristotle offers as a *refutation* of Plato precisely the point which, according to Taylor's interpretation, is a striking feature of Plato's own theory: that fire is lighter in the larger quantity. According to Taylor, this is *true*, for Plato, in the case of fire which is measured at the centre.¹²

¹² I am perhaps wrong to face Cherniss with this *third* objection, since, as I have noted, he does not make it clear whether he means to adopt both features in Taylor's interpretation: the comparison between different elements and also the comparison between different quantities of the same element. For this ambiguity in his account, see below Note 3, esp. pp. 331-4. For my own interpretation of this point in Aristotle's criticism of Plato, see below pp. 199-210, esp. p. 208 n. 17 below.

(vi)

Cherniss' massive work, *Aristotle's criticism of Plato and the Academy*, has determined the approach of a whole generation of scholars to the intricate problem of how we are to relate what Aristotle tells us of Plato with what we can read for ourselves in Plato's extant writings. According to Cherniss, Aristotle persistently fails to understand Plato's theories and falsifies their meaning, so much so that an interpretation which succeeded in finding some basis for Aristotle's criticisms, and even in giving some colour of justification for them, would almost for that very reason be suspect as a correct account of Plato's ideas.

I hope that, at least on this one point, Plato's theory of weight, I may be able to persuade the reader that there is room for a new and radically different approach to that adopted by Cherniss.

I return to the interpretation that I have offered of Plato's later theory. At this point in his treatise, Plato's explicit concern is exclusively with the measurement of an element in its 'own' place, i.e. of fire at the circumference and of earth at the centre. In both cases, Plato's conclusion is that the larger quantity of either element is the heavier. If Plato by implication intends to measure either element in the 'opposite' place, i.e. fire at the centre or earth at the circumference, then in that case, I have argued, Plato's final definition requires us, even so, to suppose that the larger quantity of either element is still invariably the heavier. For in either case, I have suggested, what we shall be measuring is the resistance of an element, whether the resistance which we must overcome in dragging an element away from its parent body, in the case of fire measured at the circumference and of earth measured at the centre, or the resistance which an element would exert if we seek to prevent it returning to its parent body, i.e. if we measure fire at the centre or earth at the circumference.

On this interpretation, it is possible to reconcile Plato's two theories:

1. On the earlier theory, the body with fewest triangles is lightest, and the body with the larger number of triangles is the heavier.
2. On the later theory, the larger body is again invariably the heavier, while the smaller body is the lighter.

On this interpretation, therefore, it is possible to begin to understand why Aristotle should speak of Plato's theory as determined (solely) by the number of triangles.

For on this interpretation it will be true, of the earlier and the later theory alike, that the heavier quantity, whether of two portions of the same element (in the earlier and in the later theory), or of portions of dif-

ferent elements (in the earlier theory), will be the one which contains a larger number of triangles.

This interpretation therefore opens the door to our understanding why Aristotle should have thought himself able to treat Plato's theory as depending solely upon the number of triangles, and why therefore he should have taken the earlier definition as sufficiently representative of Plato's theory.¹³

§ 2. 'SENSIBILIA'

I have claimed that on the interpretation that I have offered of Plato's two theories we can begin to understand Aristotle's criticism of Plato, in so far as the determination of weight by number, which Aristotle takes as a sufficient representation of Plato's theory, is—on the interpretation that I have offered—common to both Plato's theories.

But this is, so to speak, only the material condition for a successful resolution of Aristotle's evidence. Granted that the correlation of weight with number is common to the two theories, why does Aristotle make no mention of the features that are peculiar to the later theory, other perhaps than the overt comparison of different quantities of the same element, or of the same substance?

How can Aristotle have been led so to whittle away the complexity of Plato's later analysis in the *Timaeus* as to leave only the definition of weight in terms of number, wholly irrespective, or so at least it would seem, of the tendency of each body to move towards its like?

¹³ I have not noted opinions other than those of Cherniss. To some extent Cherniss was already swimming with the tide. Archer-Hind had written, *Timaeus* edn 229: 'Aristotle in his criticism of Plato's theory ... simply ignores the whole point of it from beginning to end' (cf. vol. i pp. xv-xvi, and see further p. 210 n. 18 below). William K. C. Guthrie had written, of Aristotle's opening criticism, *De caelo* iv 2, 308b12-21, 'The suppression of Plato's premises here is extraordinary', *De caelo* Loeb edn (Cambridge Massachusetts, 1939) 334 n. a (see further pp. 199ff. esp. p. 200 below).

The publication of Cherniss' work has made this attitude seemingly ineradicable. For example, Cherniss' influence dominates the attempt that McDiarmid makes to explain the criticisms which Theophrastus brings against Plato: see p. 218 n. 5 and pp. 334-5 below. Ingemar Düring writes in the same spirit, *Aristoteles, Darstellung und Interpretation seines Denkens* (Heidelberg, 1966) 357: 'In der Polemik gegen Platons Ansicht vom Schweren und Leichten zeigt er sich (sc. Aristoteles) von seiner schlimmsten Seite.' Moraux, like Cherniss, adopts Taylor's interpretation of the *Timaeus*, and therefore, like Cherniss, he finds it 'étrange ... qu'Aristote ne s'attache guère à critiquer le long développement consacré dans le *Timée* aux notions de pesanteur et de légèreté' (*De caelo* Budé edn, cxlvii: see further Note 3, esp. pp. 334-5 below, and cf. p. 79 n. 3 above). Moraux is however independent of Cherniss, in suggesting that Aristotle's criticism of direction is intended as sufficient refutation of Plato's later theory: on this point, see further pp. 185ff. and 230ff. below.

Equally, why does Aristotle make no mention of the factor of resistance, which one might have thought was the primary and the most striking feature of the second branch of Plato's theory?

To these questions I shall devote this and the remaining sections of this chapter and the next. There are, I think, several reasons which have led Aristotle to see the definition of weight by number as not only one feature in the later theory, but as the only significant feature in it. For the moment, I limit myself to the simplest, and the most general, of these: the different conceptions which Aristotle and which Plato have of the nature of *sensibilia*.

(i)

Plato's general aim, in the *Timaeus* as in the *Theaetetus*, is to establish the notion of *sensibilia* as arising exclusively from the conjunction of perceived object and percipient. Aristotle's own preoccupation does not lie along quite the same path. For Aristotle, the secondary and dependent nature of the *sensibilia*, which was of central importance for Plato, as it had been for Democritus, is sufficiently explained by the distinction of potency and act, at least if we leave aside for the moment the need that there then arises for the introduction of active mind. For Aristotle, the *sensibilia* do lie within the perceived object, but only in a state of potency.

Perhaps the simplest statement of this view, and one which has the advantage, for our purposes, of being presented as a refutation of earlier ways of thinking, is that contained in the third book of the *De anima*, cap. 2, 426a20-6: ἀλλ' οἱ πρότερον φυσιολόγοι τοῦτο οὐ καλῶς ἔλεγον, οὐθὲν οἰόμενοι οὔτε λευκὸν οὔτε μέλαν εἶναι ἄνευ ὀψεως, οὐδὲ χυμὸν ἄνευ γεύσεως. τῇ μὲν γὰρ ἔλεγον ὀρθῶς, τῇ δ' οὐκ ὀρθῶς· διχῶς γὰρ λεγομένης τῆς αἰσθήσεως καὶ τοῦ αἰσθητοῦ, τῶν μὲν κατὰ δύναμιν τῶν δὲ κατ' ἐνέργειαν, ἐπὶ τούτων μὲν συμβαίνει τὸ λεχθέν, ἐπὶ δὲ τῶν ἐτέρων οὐ συμβαίνει. ἀλλ' ἐκεῖνοι ἀπλῶς ἔλεγον περὶ τῶν λεγομένων οὐχ ἀπλῶς.

I paraphrase:

'Those who earlier had ideas on the subject, as part of their physical speculations, went wrong on this point, in supposing, as they did, that without vision there can be nothing white or black, and that without taste there could be no flavours.

'They are right in one sense, and not in another. For the faculty of sense and the objects of sense can both be spoken of in two ways: as actual and as potential.

'What they say is true of things spoken of as actual: <it is true that without the faculty of sense there can be no actual colours and no actual flavours.> But what they say is not true of things spoken of as potential: <colours and flavours do exist potentially, even when they are not being actualised by perception.>

'The error in earlier ways of thinking lay therefore in using in an absolute or simple sense terms that cannot be so used <and that must be distinguished as actual and as potential>.'¹⁴

(ii)

On a simple level, this theory explains why Aristotle should be able to ignore the notion of resistance, and to take the definition of weight by number as sufficiently emblematic of Plato's position. From Aristotle's own point of view, he has simply taken what we might call the 'objective correlate' in Plato's theory of weight as defined by resistance, and ignored the rôle of the percipient in actualising the quality which already exists in a state of potentiality.

For weight as defined by number is precisely the 'objective' fact which we measure in the calculation of resistance. What Aristotle has done is to ignore the 'subjective' factor: the necessity for a sensible percipient, if heavy and light are to be treated, like hot and cold, or hard and soft, as arising only from the conjunction of perceived object and percipient.

At the same time, the point to appreciate, I would suggest, is that basically Aristotle is able to do this, only because the definition of weight by number does indeed provide a crucial element in the later definition of weight in terms of resistance.

Thus Aristotle's ideas on the nature of potency and act in relation to the *sensibilia* enable him to reduce Plato's theory to a definition of weight as determined solely by the number of triangles: but only because the number of triangles is in fact an essential element in Plato's description of heavy and light, in his later passage, as measured by resistance.

(iii)

These considerations, on the nature of the *sensibilia*, are admittedly of a very simple, and a very general, kind. I have devoted a single section to them, in order to make clear, by a single preliminary example, the nature of my argument in this chapter and the next.

My initial conclusion is that the broad direction of Aristotle's criticism of Plato's theory of weight is explicable if we keep carefully to the analysis

¹⁴ The whole passage in the *De anima* runs from 425b26-426a26. Other comparable passages are *Cat.* cap. 7, 7b35-8a12 and *Met.* Γ 5, 1009a6ff., esp. 1010b31-1011a2.

I am deliberately taking a very simplified view of Aristotle's theory, as this is sufficient for the purpose in hand. I am also avoiding the question as to whether, or how far, Aristotle directly includes Plato in his description of the φυσιολόγοι in the *De anima*, and among those whom he criticises in the later part of the passage I have cited from the *Metaphysics*. My statement of the conceptual difference between Plato and Aristotle is sufficient to establish the point I have in mind, without my entering into the tricky question of Aristotle's precise doxographical intentions in the passages I have cited.

of Plato's theory that I offered earlier in this study. On Plato's theory of weight as defined by resistance, we measure a body only in relation to its movement towards or away from its parent body, and when we do so the larger quantity is invariably the heavier, while the smaller quantity will be lighter. This interpretation of Plato's theory is compatible with, and indeed embodies, the premiss that a body is lighter or heavier than another depending upon the number of primary particles from which it is constituted.

The problem therefore is why Aristotle has taken this feature as sufficient indication of Plato's theory, and why he has suppressed the features peculiar to Plato's later analysis. So far, the answer I suggest is that Aristotle takes the definition of weight by number as representative of Plato's theory of weight as a whole, because in Aristotle's own philosophy the perceived object does itself possess the *sensibilia*, at least in a potential form, so that the intervention of the percipient does not itself constitute the nature of the *sensibilia*, as in a sense it does for Plato.

Aristotle therefore extracts, as it were, the intervention of the sensible percipient from the theory of weight as defined by resistance, and is left, so to speak, with only the 'objective correlate', of weight as defined by number.

§ 3. WEIGHT AND DIRECTION

(i)

There is however another, and more particular, reason for Aristotle's reduction of Plato's theory to a theory of weight as defined by number, which will become apparent, if we consider the significance, for Aristotle, of Plato's account of position and direction.

The definition of weight by number provides one element in the definition of weight in terms of resistance. The other equally essential element lies in Plato's analysis of direction. In the determination of weight by resistance, we measure, in effect, the *number* of triangles and the *direction* of their movement, whether towards the centre or towards the circumference.

Aristotle is able to reduce the definition of weight by resistance to the definition of weight by number in part, I have argued, because the number of triangles provides what I have called, anachronistically but conveniently, the 'objective correlate' to Plato's definition of weight in terms of resistance.

At the same time, Aristotle is able to effect this reduction in Plato's theory because, at the point at which he speaks of Plato's theory as dependent upon the number of equal triangles, he has already disposed

of the distinction which Plato had attempted to insist upon, and which had been central to Plato's own expression of his theory, of 'up' and 'down' as applying equally to centre and to circumference.

These two features therefore conspire to determine the form in which Plato's theory of weight appears in Aristotle.

1. The significance that the intervention of the sensible percipient had held for Plato is minimised by Aristotle's own conception of the nature of the *sensibilia*.

2. Of the two 'objective' correlates in the definition of weight by resistance, Plato's conception of the movement of elements in different directions is also without real meaning for Aristotle.

The result is that the number of elemental particles is left as the only significant feature, for Aristotle, of the earlier, as of the later, theory.

(ii)

This new and *second* factor in my argument will perhaps seem doubly paradoxical. To the historian's eye, Plato's notion of the distribution of elements among the universe on the principle of like to like, such that each element moves spontaneously to its 'own' place, is the point at which Plato's cosmogony most strikingly approximates to Aristotle's own conception of the cosmos. The difference that, for Plato, the attraction is an attraction of like elements, while for Aristotle the attraction is an attraction of place, is important perhaps, but of marginal significance, one might have thought, for the consideration of weight.

At the same time, an honest reader will, I think, find it difficult, on a first reading, to see any point of substance in Aristotle's insistence that circumference and centre must be reckoned as respectively 'up' and 'down', as against Plato's conclusion that no part of the universe can in itself be reckoned as exclusively 'up' or 'down'. One may indeed be tempted to think that this is hardly more than a quibble: which cannot have seriously affected Aristotle's understanding of Plato's theory of weight.¹⁵

But the truth, I believe, is that in Aristotle's eyes Plato's analysis of 'up' and 'down' as relative to an observer, or to the movement of an element, negated the advantages of Plato's conception of the distribution of elements, at least as regards the distinction of heavy and light. For the criticism which Aristotle makes of Plato's analysis of direction, at the

¹⁵ Needless to say, this is in fact one of the ways in which Simplicius seeks to effect his *rapprochement* of Plato and Aristotle, in the comparison of their theories included in his long diatribe against Philoponus, *De caelo* 66.4-91.20, esp. 69.11-15, cf. 712.31-713.7.

beginning of the fourth book of the *De caelo*, proves to be essential to the discrepancy which Aristotle sees between his own conception of weight and the ideas of his predecessors, including Plato.

(iii)

Thus almost immediately prior to the criticisms which I quoted at the beginning of the section preceding this, Aristotle re-states the analysis of 'up' and 'down' which Plato offers as a preliminary to his own analysis of weight in terms of resistance, in the pages of the *Timaeus* that I have already analysed at length (62C3ff.). It is 'eccentric', Aristotle tells us, to claim that there is no part of the universe which is 'up' or 'down', on the grounds that the universe is entirely uniform, and that anyone who walked around the surface of the earth would repeatedly be standing upside down from the way he was before. Although Plato is not named, this must refer to the passage which I have analysed from the *Timaeus*.

Aristotle writes, *De caelo* iv 1, 308a17-21: ἄτοπον γὰρ τὸ μὴ νομίζειν εἶναι τι ἐν τῷ οὐρανῷ τὸ μὲν ἄνω τὸ δὲ κάτω, καθάπερ τινὲς ἀξιοῦσιν· οὐ γὰρ εἶναι τὸ μὲν ἄνω τὸ δὲ κάτω φασίν, εἴπερ πάντῃ ὁμοίός ἐστι, καὶ πανταχόθεν ἀντίπους ἔσται πορευόμενος ἕκαστος αὐτὸς αὐτῷ.

I paraphrase:

'It is eccentric to refuse to believe that there does exist something in the universe which is "up", and something else which is "down".'

'Some people do think it right to refuse to believe this.

'They deny that there exists what is "up" and what is "down", since <the universe, they say,> is everywhere alike, and if someone walked <all the way around the earth> he would find himself at every point standing upside down to the way he was <when he was at the opposite point of the earth's circumference>.'¹⁶

¹⁶ This criticism is repeated in the *Physics*, iv 1, 208b8-22, though in a more general form, and in relation to all six 'directions' (up/down; forwards/backwards; right/left); Plato may possibly be again in mind. Earlier in the *De caelo* Aristotle possibly fabricates from the *Timaeus* an argument against the Pythagorean belief in a left and right to the universe. Aristotle himself does not accept the objection, ii 2, 285a31-b5: οὐ δὲ γὰρ ἀπορεῖν διὰ τὸ σφαιροειδὲς εἶναι τὸ σχῆμα τοῦ παντός, ὅπως ἔσται τοῦτου τὸ μὲν δεξιὸν τὸ δὲ ἀριστερόν ... ἔξει μὲν γὰρ τὴν δύναμιν διαφέρουσιν, δόξει δ' οὐ διὰ τὴν ὁμοιότητα τοῦ σχήματος.

There is one potential discrepancy between Plato's text and Aristotle's criticism of it. In the *Timaeus* the cosmic traveller walks around the earth: αὐτό at 63A2, or so I have argued pp. 17-18 above, plainly refers to the solid body of the preceding sentence, 'placed in the centre of the whole', 62D12-63A1, and which in the context of Plato's argument clearly represents the earth. Aristotle in the *De caelo* alludes only to 'the universe' (τῷ οὐρανῷ, 308a17) or to 'the whole' (τοῦ παντός, a21). There is therefore an ambiguity in Aristotle's text, since the clear allusion to the *Timaeus* leads us to see the earth as the location of the verb πορευόμενος (308a20), as it is for the identical verb in Plato (πορεύοιτο, 63A2), while a reader innocent of Plato's text might be led to imagine the cosmic traveller of the *De caelo* as walking around the inner circumference of the heavens, as he is pictured as doing in some medieval commentaries on the *De caelo*. This ambiguity should be recognised in the

The truth, Aristotle tells us, is that the circumference is 'up' and the centre is 'down'. This, Aristotle tells us, is what most ordinary people do think, except in so far as, not realising that the whole world is spherical, they imagine that there is only a single hemisphere above our heads. If they did but realise that the world was the same all the way round, then they too would call the circumference 'up' and the centre 'down'.

Aristotle writes, iv 1, 308a21-9: ἡμεῖς δὲ τὸ τοῦ παντὸς ἔσχατον ἄνω λέγομεν, ὃ καὶ κατὰ τὴν θέσιν ἐστὶν ἄνω καὶ τῇ φύσει πρῶτον· ἐπεὶ δ' ἔστι τι τοῦ οὐρανοῦ ἔσχατον καὶ μέσον, δῆλον ὅτι ἔσται καὶ ἄνω καὶ κάτω, ὅπερ καὶ οἱ πολλοὶ λέγουσι, πλὴν οὐχ ἰκανῶς. τούτου δ' αἴτιον ὅτι νομίζουσιν οὐχ ὅμοιον εἶναι πάντῃ τὸν οὐρανόν, ἀλλ' ἐν εἶναι μόνον τὸ ὑπὲρ ἡμᾶς ἡμισφαίριον, ἐπεὶ προσυπολαμβάνοντες καὶ κύκλῳ τοιοῦτον, καὶ τὸ μέσον ὁμοίως ἔχειν πρὸς ἅπαν, τὸ μὲν ἄνω φήσουσιν εἶναι, τὸ δὲ μέσον κάτω.

I paraphrase:

'What we say is that the extreme boundary of the whole <body of the universe> is "up": it is "up" in virtue of its position and as well as that it is by nature prior.

'Now since there does exist an outermost boundary to the universe, and since there is also a centre <to the universe>, it clearly follows that there will exist both "up" and "down": <the circumference will be "up", and the centre will be "down".>

'That in fact is just what most people do say, only they do not go far enough.

'The reason for this <shortcoming on their part> is that they fail to appreciate that the universe is the same all the way round, and instead they suppose that the hemisphere above our heads is the only one there is.

'Once they had also got it into their heads that it went all the way round like that as well, and that the centre was in the same relation to the whole <of the universe, to the part which is on the other side of the earth no less than to the part which is above our heads>, then they would call one part <the circumference> "up", and the centre "down" <just as we do>'.¹⁷

(iv)

I return, for a moment, to Plato's own criticism of his predecessors.

At the beginning of my study of Plato, I outlined Plato's criticism of earlier theories, or at least of earlier common ways of thinking, possibly including Democritus' theory of cosmic weight.¹⁸ In this criticism Plato

translation of Aristotle's text, although since the conclusion of Plato's argument is at once applied to 'the whole' (τὸ ὅλον, 63A4), the distinction does not affect the substance of Aristotle's argument.

¹⁷ The same point seems to be alluded to at the end of Aristotle's discussion in the *Physics*, iv 4, 212a21-9, where τὸ ἔσχατον τὸ πρὸς ἡμᾶς τῆς κύκλῳ φορᾶς (a21-2) perhaps picks up the point in the *De caelo* that most people think only of 'the hemisphere above our heads'.

¹⁸ *Tim.* 62C3-8, chapter I § 2, pp. 5-9 above.

tells us that there are not two places, up and down, which 'by nature divide the whole between them': 'down' towards which anything travels which has any bulk, and 'up' to which things travel only involuntarily. The point which I earlier alluded to, and which must now be uncovered, is that Plato's own theory corrects only the first part of this assumption, and not the second.

1. Plato *denies* that the universe can 'by nature' be divided into up and down, or above and below.

2. But Plato *retains the notion* that a body travels downwards if left to its own devices, as it were, and that it will travel upwards only involuntarily.

The *difference* therefore between Plato and his predecessors lies *only* in Plato's abandoning the simple identification of 'above' and 'below' with different regions of the universe. Plato *still* supposes that any body which travels 'upwards' is moving counter to its natural tendency, and that only when a body moves 'downwards' will it be moving towards its natural place.

At the same time, Plato retains the notion that a smaller portion of any body will the more readily move counter to its natural tendency, and will therefore be lighter, while a larger portion of any body will be the more likely to return to its native element, and will therefore be heavier.

Altogether therefore Plato retains the Presocratic and (possibly) Democritean associations, whereby:

1. What is larger, moves downwards, and is heavy.
2. What is smaller, moves upwards, and is light.

Plato's innovation therefore—from this point of view, his *only* innovation—is to abandon the identification of 'up' and 'down' with the circumference and the centre.

For Plato endorses the view that in the universe there are 'opposite places'; but he rejects the view that these 'opposite places' (for Plato: the centre and the circumference) can be identified with the opposition of 'up' and 'down'.¹⁹

(v)

Aristotle, in effect, adopts the opposite policy.

In the passages that I have quoted, Aristotle identifies 'up' and 'down' with Plato's 'opposite places' (the circumference and the centre); but he

¹⁹ Plato's own belief in the opposition of place: for example, 63D5-6. See pp. 26 and 40-1 above.

abandons the Platonic and the Presocratic correlation of size, direction and weight.

1. For Plato, a larger quantity of earth, or of fire, is heavier and will move 'downwards'; while a smaller quantity of earth, or of fire, will be lighter and will move 'upwards'.

2. But for Aristotle it is only a larger quantity of earth that will be heavier, and will move 'downwards'; a larger quantity of fire is reckoned by Aristotle as moving 'upwards', and as being light.

From this point of view, therefore, Plato and Aristotle have adopted precisely opposite conclusions. And from this point of view, therefore, it can be seen why Aristotle should group Plato with the Presocratic thinkers in being opposed to the Aristotelean innovation.

Aristotle claims that he is following the traditional association in reckoning movement to the centre as movement downwards, and movement to the circumference as movement upwards: which is indeed more or less the association that Plato writes of as being 'the way that we have grown accustomed to speaking'.²⁰

Aristotle's conscious innovation lies in his insistence that it is no less natural for fire to travel upwards than it is for earth to travel downwards.

For Aristotle, the operative point in Plato's opening criticism therefore is not whether there are 'two places, "up" and "down"', which 'divide the whole between them': for Aristotle thinks that the popular way of thinking is right in this respect.

In Aristotle's eyes, the operative point in Plato's formulation is whether or not things travel 'upwards' only 'involuntarily': and this is precisely the feature in Plato's criticism of his predecessors which is left intact in Plato's own theory.

(vi)

I summarise. Plato's own criticism of his predecessors contains two features:

1. that the universe is divided into 'up' and 'down'.
2. that bodies move downwards if left to their own devices, as it were, and that things move upwards only 'involuntarily'.

Plato denies the *first* point (that the universe is divided into 'up' and 'down'), while retaining the terminology of the *second* point (an element is 'forced' away from its parent body, and so moves upwards 'involuntari-

²⁰ 'More or less', from Aristotle's point of view. See the footnote following this.

ly'). Aristotle denies the *second* point (that things move upwards only 'involuntarily'), while retaining the *first* point (the universe is divided into 'up' and 'down': for Aristotle this means that the circumference is 'up' and the centre 'down').

From Aristotle's point of view, therefore, Plato has abandoned the essential recognition to which the separate movements of earth and of fire might otherwise perhaps have entitled him, that it is the nature of fire to travel upwards no less than of earth to move downwards.

For in claiming that the movement of fire towards the circumference, no less than of earth towards the centre, is movement downwards, and that the larger quantity of either element is the heavier, Plato in effect groups himself with earlier thinkers, for whom—from Aristotle's point of view—the elements have 'natural' movement in only a single direction.

From this it follows that the difference of direction, no less than the intervention of the percipient, is rendered inoperative in Plato's theory, when seen from Aristotle's point of view: with the result that, on both counts, number is left as the only *differentia* of heavy and light.²¹

²¹ I return to this subject in Note 9, pp. 387-403 below, where I attempt to present the same facts from a point of view less closely identified with that of Aristotle.

CHAPTER TEN

ARISTOTLE ON PLATO AND DEMOCRITUS

§ 1. MONISM AND PLURALISM

So far, my central point has been that Plato's earlier theory, where weight is defined by number, is compatible with, and is indeed contained as a premiss within, Plato's later definition of weight in terms of resistance: for in Plato's later theory, whether we take it in a restricted or in an extended sense, the larger quantity of either element—the quantity therefore with the larger number of triangles—is, I have argued, invariably the heavier.

Following on from this alignment of the two theories, I have sought to provide reasons why Aristotle should have neglected the factors which are peculiar to Plato's later theory, and so far I have offered two considerations. For Aristotle, the intervention of the sensible percipient is irrelevant to the definition of weight, for in Aristotle's philosophy the *sensibilia* do not arise solely from the conjunction of perceived object and percipient, as they do for Plato: the *sensibilia*, for Aristotle, already exist, at least potentially, within the object perceived. Secondly, I have sought to argue that Plato's analysis of direction, whereby fire and earth alike move 'downwards' in travelling respectively towards the circumference and towards the centre, and whereby the larger quantity of either element is the heavier, will have vitiated, from Aristotle's point of view, the fact that in Plato's system fire and earth do, as it were, travel 'naturally' each to its own place. For Plato's formulation has obscured, and indeed prevented, recognition of what for Aristotle is the essential innovation in his own theory: namely that fire travels upwards 'by nature' and is lighter in the larger quantity.

If we disregard, in Plato's theory, the intervention of the percipient, and if we allow the description of earth and of fire as each moving 'downwards' when it returns to its parent element to override the fact that earth and fire nonetheless move at such times in opposite directions, then the only factor which remains operative in the later theory, of weight as defined by resistance, is precisely the factor which the later theory shares with the earlier: namely that a body is heavier, if it contains a larger number of elemental triangles.

And this is precisely the version of Plato's theory that Aristotle states, and criticises, in the opening chapters of the fourth book of the *De caelo*.

Although the considerations that I have advanced so far are sufficient, it seems to me, to explain and to justify Aristotle's behaviour—in so far as 'justification' is a term that can properly be employed in an historical enquiry of this kind—nonetheless the most powerful motive in the attitude which Aristotle adopts towards Plato's theory has not yet, I think, been touched upon directly.

For Aristotle, the *fons et origo malorum* in Plato's theory will have lain, I suspect, not in the intervention of a percipient, which Aristotle will probably have seen as an unnecessary rather than a disruptive factor, nor even primarily in the 'eccentric' analysis of direction, which if it had existed alone even Aristotle might have recognised as more a question of terminology than of substance; on the question of weight, as throughout his criticism of Plato's physical theory, the root of the trouble will have lain, for Aristotle, in Plato's theory of triangles as the *prima materia*.

And here Aristotle's critique of Plato presents the modern reader with a fresh and surprising paradox. For Aristotle's own conception of the relation of the elements to the *prima materia* reduces Plato's theory of triangles and Democritus' theory of the atoms to an error that is ultimately the same for the two theories.

(i)

In the course of the long series of criticisms to which Aristotle subjects Plato's theory of elemental triangles in the opening chapter of the third book of the *De caelo*, Aristotle writes as follows, iii 1, 299b31-300a7: ἔτι εἰ μὲν πλήθει βαρύτερα τὰ σώματα τῶν ἐπιπέδων, ὥσπερ ἐν τῷ Τιμαίῳ διώριται, δῆλον ὡς ἕξει καὶ ἡ γραμμὴ καὶ ἡ στιγμὴ βάρος· ἀνάλογον γὰρ πρὸς ἄλληλα ἔχουσιν, ὥσπερ καὶ πρότερον εἰρήκαμεν. εἰ δὲ μὴ τοῦτον διαφέρει τὸν τρόπον ἀλλὰ τῷ τὴν μὲν γῆν εἶναι βαρὺ τὸ δὲ πῦρ κοῦφον, ἔσται καὶ τῶν ἐπιπέδων τὸ μὲν κοῦφον τὸ δὲ βαρὺ. καὶ τῶν γραμμῶν δὴ καὶ τῶν στιγμῶν ὡσαύτως· τὸ γὰρ τῆς γῆς ἐπίπεδον ἔσται βαρύτερον ἢ τὸ τοῦ πυρός.

I paraphrase:

'There are two possibilities (μὲν ... δέ ...). If the idea is that bodies are heavier by reason of the number of surfaces <which they are made from>, which is the definition given in the *Timaeus*, then obviously both a line and a point will have heaviness <as well>. For the relation of one to the other <i.e. of point to line, or line to surface, or surface to solid> is <in each case> equivalent: <so that if a body is to be resolved into surfaces that have heaviness, then surfaces should be resolved into lines that have heaviness, and lines should be resolved into points that have heaviness, for> as I have argued already <there is no justification for stopping the process at one level and not at the next>.

'If that is not the way things are going to be, if the idea is instead that it is by reason of earth being heavy and fire light that bodies differ <in

weight >, then it will follow <on Plato's theory> that the surfaces <from which bodies are constituted> will also be distinguished as light and as heavy, and the same must then apply to lines, yes and to points: the surface from which earth is made will be heavier than the surface from which fire is made.'

The statement of Plato's theory which Aristotle offers here, that bodies are more heavy or less so dependent upon the number of surfaces from which they are constituted, is identical in substance to the formulations which I have quoted already from the fourth book: that 'one thing is heavier' than another 'if it is made from a larger number of the same parts, and lighter if it is made from fewer parts', or that each body is 'heavier, depending upon its preponderance of equal parts'.¹

The difference in terminology between 'parts' (μέρη), in the fourth book, and 'surfaces' (ἐπιπεδα), in the third book, is sufficiently explained by the ambiguity in Plato's own theory, and by Aristotle's preoccupation, in the third book, with precisely the point that solid bodies, with weight, cannot be generated from surfaces, or from points, that are without weight. This is a question to which Aristotle will return in the fourth book, in his comparison of Plato and the Atomists; but in the initial criticisms of the fourth book it is a point which Aristotle is content to let lie.²

In the passage I have quoted, Aristotle's first criticism, after his statement of Plato's thesis, is indeed avowedly a repetition of—or perhaps one should say a variation on—this same point, the discrepancy between surface and solid.³ Aristotle has already argued, against Plato, that if one is to resolve solid bodies into surfaces, then there is no reason why one should not resolve surfaces into lines, and lines into points. But in that case lines and points, as well as surfaces, must have weight, if the bodies which are produced from them are to have weight: and that Aristotle sees as controverting the whole distinction between mathematical and physical realities.⁴

It is Aristotle's second criticism which is germane to our purpose.⁵ If the number of elemental surfaces were not taken as a sufficient criterion of weight, Aristotle argues, but if earth were recognised as being by nature heavy, and if fire were recognised as being by nature light, then

¹ iv 2, 308b3-12, see pp. 176-7 above. Cf. pp. 85-7 above.

² The criticism is repeated at *De caelo* iv 2, 308b35-309a2. For an analysis of the meaning of this passage, and its relation to Aristotle's argument as a whole, see vol. i pp. 80ff.

³ The initial statement of Plato's theory, 299b31-300a1. The first criticism, 300a1-3. The second criticism, 300a3-7.

⁴ This criticism is spelt out at some length in the pages immediately preceding the lines that I have quoted, *De caelo* iii 1, 298b33-299b31.

⁵ The second criticism, iii 1, 300a3-7.

surfaces—and lines and points—would also have to be distinguished as heavy and light: the kind of surfaces which constituted earth would have to be heavy, while those which constituted fire would have to be light.

It is this criticism, I think, which most clearly indicates what is for Aristotle the fundamental error in Plato's theory of weight, and in his physical philosophy as a whole: namely that Plato's philosophy is essentially reducible to a form of monism.

(ii)

I return for a moment to the considerations that I advanced in my last chapter. There are three factors which are associated in Plato's preoccupations, as in those of Aristotle: size or number, weight and direction. Plato supposes that a larger quantity of either element, fire or earth, will be more difficult to drag away from its parent body, and that a smaller quantity will be easier to move. At the same time, Plato regards a body which is returning to its native element as moving 'downwards', while a body which moves away from its native element is regarded as moving 'upwards'. Plato therefore supposes that a *larger* quantity of either element will be *heavier* and will move *downwards*, while a *smaller* quantity will be *lighter* and will move *upwards*.

Aristotle, on the other hand, breaks the correlation between size and weight: a large quantity of earth will be heavier than a smaller quantity, but a large quantity of fire will be lighter than a smaller quantity.

Now further, in the *De caelo*, Aristotle regards this distinction as the primary criterion for the separate identity of earth and of fire. The elements for Aristotle are one, in the sense that they are mutually transformable. There must therefore exist a common substrate which will underlie the transformation from fire to earth.⁶ But the elements as they actually exist, and as we perceive them to be, have each a real difference of identity, which in the case of earth and of fire is characterised primarily by their possession of opposite forms of absolute weight: earth is heavy absolutely, fire is light absolutely. From this it follows, for Aristotle, that earth is invariably heavier in the larger quantity, and that fire is invariably lighter in the larger quantity.

In denying that the larger quantity of any element is lighter, Plato therefore appears to have compromised, and indeed to have denied, this radical difference between the nature of the elements. If a larger quantity of fire, no less than of earth, is designated as being heavier, then there can be no radical difference of kind between the two elements.

⁶ Cf. *De caelo* iv 4, 312a17-21; this passage is taken account of briefly in my third essay.

Hence Aristotle's suggestion, in the passage I have quoted, that if Plato's theory were to escape from this *impasse*, then the elemental surfaces would themselves have to be differentiated as heavy and light, in the way that earth and fire are differentiated in Aristotle's own system.

Only so, would Plato be able to attain to a genuine pluralism.

As it is, Plato's theory of weight as defined by number, and the accompanying assumption that the larger quantity of any element is necessarily the heavier, condemns him, in Aristotle's eyes, to as sterile a form of monism as if his cosmic elements were constituted from atoms differing only in size, or were derived by mere thickening and thinning from the single *arche* of the Ionians.

(iii)

It is from this point of view, I believe, that throughout the later criticisms of the fourth book of the *De caelo* Aristotle joins the theories of Plato and of Democritus as each representing, in effect, versions of monism which differ only in their choice of atoms or triangles as the one primary substance.⁷

Thus after his long *exposé* and criticism of the atomic theory, and immediately before the exposition of his own ideas, Aristotle joins Plato and the Atomists in a criticism turned against 'those who attribute a single material principle to all things, or those who have more than one material principle but no more than a pair of opposites' (iv 2, 309b29-33).

Void and *plenum* exemplify a pair of opposite principles. Against the alternative proposition, Aristotle writes that 'if there is a single material principle, then there cannot be any distinction between what is heavy absolutely and what is light absolutely, in the way that there cannot be for those who have bodies made out of triangles', iv 2, 309b33-4: *μᾶς μὲν γὰρ οὕσης* (*sc. τῆς ὕλης*) *οὐκ ἔσται τὸ ἀπλῶς βαρὺ καὶ κοῦφον, ὥσπερ τοῖς ἐκ τῶν τριγώνων συνιστᾶσιν*. This abbreviated criticism repeats essentially the purport of the criticism that I have quoted from book three. The triangles are reckoned as a single material principle: they would have to be differentiated as heavy and light, if Plato were to be able to account for the existence of elements with opposite forms of absolute weight.

⁷ For Aristotle's criticism of the Atomists, cf. *De caelo* i 7, 275b29-276a6, and the passages from book four analysed briefly in my earlier essay, vol. i ch. I §§ 2-5, pp. 6-40, and partly repeated in what follows. In these passages I identify the Atomists with those who believe in 'void and plenum' (iv 2, 310a1; cf. iv 5, 312b21) or in 'solid particles' (iv 5, 312b29-30); those who doubt this identification must await my examination of Aristotle's criticisms in volume three. For the comparison of the Atomists with Plato, cf. vol. i p. 38 n. 1.

After the exposition of his own theory, Aristotle repeats essentially this same form of criticism, with the difference only that atoms and void are now treated as alternative determinants of weight, and the identification of the Platonic and the atomic theory, or at least of one version of the atomic theory, is therefore now complete.

If there is only a single material principle for all things, as are the triangles *or* void *or* plenum, then there can be no distinction between what is heavy absolutely and what is light absolutely, iv 5, 312b20-8: εἰ μὲν γὰρ μία ὕλη πάντων, οἷον ἢ τὸ κενὸν ἢ τὸ πλήρες ... ἢ τὰ τρίγωνα, ἢ πάντα ἄνω ἢ πάντα κάτω οἰσθήσεται, ἢ δὲ ἑτέρα φορά οὐκέτι ἔσται· ὥστ' ἢ κοῦφον οὐδὲν ἔσται ἀπλῶς ... ἐὰν δὲ τὸ κενὸν ἢ τι τοιοῦτον ὃ αἰεὶ ἄνω, οὐκ ἔσται ὃ αἰεὶ κάτω.

I paraphrase:

'If there is a single material principle for all things, whether it be void or plenum ... or triangles, then either everything will travel upwards <by nature> or everything will travel downwards <by nature>, and <in either case> there will no longer be <natural> movement in the other direction.

'Consequently, either there will be nothing that is light absolutely ... or, if <the material principle is> void or something of such a kind that it travels always <and only> upwards, then there will be nothing that travels always <and only> downwards <by nature, and so is heavy absolutely>.'

Similarly, in the continuation of this same passage, Aristotle argues that there can be more triangles or more solid particles in a quantity of air, for example, than in a certain quantity of earth, so that the air should be heavier, and should move downwards faster than the earth, whereas in fact, Aristotle holds, this is impossible, iv 5, 312b28-31: καὶ τῶν μεταξὺ δὴ ἔνια ἔσται κάτω θαῦτον γῆς· ἐν γὰρ τῷ πολλῷ ἀέρι τρίγωνα πλείω ἢ τὰ στερεὰ ἢ τὰ μικρὰ ἔσται. οὐ φαίνεται δ' οὐδὲ ἐν μόνον ἀέρος κάτω φερόμενον.

I paraphrase:

'And what is worse, some of the intermediate bodies will travel downwards faster than earth.

'For there will be more triangles or more solid <particles> or more small <particles> in a large quantity of air <than in a small quantity of earth, so that air would travel downwards more quickly>.

'But no single quantity of air is ever seen to move downwards <faster than earth>.'

(iv)

In the criticisms that I have listed, there are significant differences attaching to whether Aristotle compares elements with relative or with absolute weight, and attaching also to whether Aristotle uses speed or displacement as his criterion of weight.

However, these refinements, and elaborations, of Aristotle's criticisms I shall leave for the third and fourth essays in this series, since they are best taken in conjunction with Aristotle's criticism of the atomic theory, and can best be understood in the light of the detailed criteria which Aristotle provides for his own distinction of relative and absolute weight, and which I shall suggest, in my later essay, have in part been formulated by Aristotle precisely in order to protect the independence of his own theory from what Aristotle sees as the danger of the atomic theory of composite weight.

For the moment, my intention is to isolate only the paradox presented by the most obvious feature of these criticisms: Aristotle's treatment of Plato's theory as a form of monism, and in particular his treatment of Plato's theory as being on all fours, as it were, with that of Democritus.

The repeated juxtaposition of Plato and Democritus marks in an extreme form the interpretation which Aristotle employs of Plato's theory, of weight as sufficiently defined by number. For the essential point in both theories, from Aristotle's point of view, is that they adopt a simple correlation of weight with size, whereby the larger quantity of any element is heavier than a smaller quantity, no matter whether it be earth or fire. This inevitably reduces both theories to the possession of a single ultimate material substance, and wholly nullifies, from Aristotle's point of view, Plato's insistence that in his own universe, as opposed to that of earlier thinkers, including Democritus, fire and earth travel spontaneously in opposite directions, and that fire therefore, no less than earth, has its own proper place within the universe.

From Aristotle's point of view, Plato has failed to accompany this insight with the two criteria that would alone have ensured the separate identity of fire: that fire has natural movement 'upwards', and that by nature it is light absolutely and therefore invariably lighter in a larger quantity.

In Aristotle's own philosophy, these two criteria are indispensable to the conception of a natural place for fire, distinct from that of earth, and without them Plato's theory is reduced to a simple identification of weight and of number, which in the course of Aristotle's criticism becomes rapidly indistinguishable in practice from the theory of the Atomists.

(v)

I summarise. The fundamental error in Democritus' philosophy lies, for Aristotle, in its monism. In Democritus' system, everything has a natural tendency to move downwards, i.e. towards the centre, and things move upwards only 'involuntarily'. There is nothing therefore that

Aristotle can recognise as light absolutely, nor therefore can there be any essential difference between the elements.⁸

Plato, we might think, would escape from this criticism, in that he distinguishes the tendency of the various elements to move in different directions: fire moves to the circumference, and earth moves to the centre, precisely as in Aristotle's own system.

But the account which Plato gives of the distinction between fire and earth vitiates, in Aristotle's eyes, its potential significance. For Plato continues to describe the larger portion of either element as moving downwards and as being heavy, while the smaller portion is lighter and moves upwards only involuntarily.

From Aristotle's point of view, Plato's theory is therefore reduced to a level with that of Democritus. If we exclude for the moment the refinements, and the complications, arising from the Atomists' introduction and use of the void, then in either theory there is, from Aristotle's point of view, a single kind of material substance, and something is heavy or light depending solely on the number or the size of its constituents.

§ 2. QUANTITIES OF FIRE

I return therefore to the first criticism which Aristotle makes of Plato's theory—after his remarks on Plato's eccentric terminology for centre and circumference—in a passage mentioned earlier.⁹ A larger quantity of fire will contain more triangles, and on Plato's theory it will therefore be heavier. In that case, Aristotle argues, it should move towards the circumference more slowly than a smaller quantity. But in fact, Aristotle believes, the opposite is the case: the larger quantity of fire will move towards the circumference more quickly, and it will move more slowly away from the circumference.

Aristotle writes, *De caelo* iv 2, 308b12-21: οὕτω δὴ διωρισμένων οὐκ εἴρηται περὶ τοῦ ἀπλῶς κούφου καὶ βαρέος· νῦν γὰρ τὸ μὲν πῦρ αἰεὶ κοῦφον καὶ ἄνω φέρεται, ἡ δὲ γῆ καὶ τὰ γεγηρὰ πάντα κάτω καὶ πρὸς τὸ μέσον. ὥστ' οὐ δι' ὀλιγότητα τῶν τριγώνων, ἐξ ὧν συνεστάναι φασὶν ἕκαστον αὐτῶν, τὸ πῦρ ἄνω φέρεσθαι πέφυκεν· τὸ τε γὰρ πλεῖον ἦττον ἂν ἐφέρετο καὶ βαρύτερον ἦν ἐκ πλειόνων ὄν τριγώνων. νῦν δὲ φαίνεται τούναντίον· ὅσω γὰρ ἂν ἡ πλεῖον, χρούτερόν ἐστι καὶ ἄνω φέρεται θᾶττον. καὶ ἄνωθεν δὲ κάτω τὸ ὀλίγον οἰσθήσεται θᾶττον πῦρ, τὸ δὲ πολὺ βραδύτερον.

⁸ I have already considered at some length the sense in which, for various purposes, Aristotle does admit *argumenti causa* the existence in Democritus' system of something which is light absolutely (vol. i pp. 11ff.). Here I repeat only the most general tenor of Aristotle's criticism of the Atomists.

⁹ Pp. 176, 180 above.

I paraphrase:

'When <heavy and light> are defined in this way <i.e. as in the *Timaeus*>, nothing has been said about what is heavy and light in an absolute sense.

'For in the world as we see it now (*νῦν γάρ* ...), fire is always light and travels upwards, while earth, and everything made of earth, travels downwards, i.e. towards the centre. <Fire therefore is light absolutely, and earth is heavy absolutely.>

'Consequently, it cannot be the case that fire by nature travels upwards because of the small number of the triangles from which, or so they claim, each one of the bodies <we see, fire no less than earth,> is made.

'For in that case the larger quantity <of fire> would travel <upwards> less readily and would be heavier, being <made up, as it would be for them,> from a larger number of triangles.

'But in the world as we see it now, just the opposite turns out to be the case. The more <fire> there may be, the lighter it is, and the more quickly it travels upwards.

'And <conversely> for the journey from above to below: the small quantity of fire will be carried downwards more quickly; the large quantity, more slowly.'

(i)

Professor Guthrie writes of this criticism:

'The suppression of Plato's premises here is extraordinary. On Plato's definition weight is the natural tendency of bodies of like nature to come together: a small portion of earth or fire has an impulse to join the main mass. On this definition the upward motion of fire, increasing in velocity in proportion to the quantity, is explained without recourse to the hypothesis of absolute lightness, and against it Aristotle's arguments are pointless.'¹⁰

I have suggested that there are three features peculiar to Plato's analysis of weight that have led Aristotle to consider heavy and light, in Plato's system, as dependent solely upon the number of particles, despite the fact that in Plato's world, no less than in Aristotle's own, the elements are in practice distinguished by their movement each to its own place within the cosmos.

1. The intervention of a sensible percipient is a needless refinement, given Aristotle's own conception of potency and act.

2. Plato's own analysis of direction obliterates what for Aristotle is the decisive innovation in his own theory: the natural movement of fire upwards.

3. Plato's correlation of heaviness with size or number, for either element, leads Aristotle to see Plato's theory as essentially part of a monist philosophy.

¹⁰ *De caelo* Loeb edn 334 n. a.

At the same time, this first criticism of book four does seem, at first sight, especially blatant, because although Aristotle repeats Plato's definition of fire as lightest 'because of the fewness of its triangles', the circumstance which he then envisages, the comparison of a larger and of a smaller quantity of fire, is in effect precisely the circumstance which Plato himself introduces as the leading example in his later account of weight, as defined by resistance.

I have already argued that Aristotle reduces the later to the earlier theory, by discounting the features that are peculiar to the later theory. The present criticism is as it were an acid test of the reconstruction that I have proposed: can we really believe that in the comparison of a larger and a smaller quantity of fire Aristotle is able to ignore precisely those features of the Platonic theory that had centred upon, and had been drawn from, this very example—the movement of earth and fire in opposite directions, the greater resistance exerted by, or the greater force needed to move, the larger quantity?

(ii)

The reason why Aristotle is able to do so is, I believe, an interesting example of the primacy, in Aristotle's criticisms of his predecessors, of principle over fact.

By this I mean not primarily that Aristotle—sometimes—distorts the facts as presented in earlier theories, either so as to conform to the facts that he sees—or that he thinks himself to see—in the cosmos in the light of his own philosophy (as when he describes the state of total separation in Empedocles' cosmic cycle as being essentially like the world we know now, since the elements are separate and in movement, whereas for Empedocles himself Strife's total rule had been the very antithesis of the present world), or so as to conform to the facts that he thinks should follow, false though they may be, from the principles of a particular philosopher (as when he argues that the atoms of Democritus have all the same nature, and 'must' therefore have movement all in the same direction).¹¹

These distortions, when they occur, are the result of a particular orientation of interest in Aristotle. Aristotle is not primarily interested in the 'facts' which furnish the universe of earlier philosophers. Aristotle is interested in the principles and the theories by which earlier philosophers explained, or by which he thought that they should have explained, the world that they claimed as the world of their experience. It is only as a

¹¹ For the example from Empedocles, see *ECC* 10-11, 147-9, 175-7. For the example from Democritus, see my first essay, vol. i pp. 11-14, 132-42, 260-6.

consequence of this interest, and of the distortion that may occur at this level, the level of principle and of theory, that Aristotle is led either to present the facts of an earlier theory in a light alien to the context from which they were drawn (as in the example which I have quoted from Empedocles) or, on occasion, to alter the facts to what he supposed should, or 'must', have been the consequence of the theory that he has outlined (as in the instance that I have quoted from his criticism of Democritus).

In this first criticism of Plato's theory of weight in book four of the *De caelo* we have, I believe, a choice example of the way in which Aristotle can oppose a theory, not because it offers facts which conflict with his own, but because it offers a description which Aristotle believes to be wrong in principle rather than in practice; and where at the same time we also see, in embryo, the inevitable—occasional—consequence of such an orientation of interests, namely that the facts in the theory which Aristotle opposes to his own are realigned to accord with what the facts should have been if the original description of them is given the sense which it would have to have in Aristotle's own philosophy, a sense which inevitably tends to be imposed upon the original theory by the very freedom with which Aristotle juxtaposes earlier ideas to his own.

The result, in this instance as elsewhere, is far from being the product of a wilful and careless disregard for earlier ideas, which Cherniss seems to see as the leading characteristic of Aristotle's criticism of his predecessors. Still less are Aristotle's criticisms of his predecessors, rightly understood, 'pointless'. They are, I believe, a direct result of the orientation of interest that I have indicated, and if only we can sympathise with, whether or not we share, Aristotle's overriding interest in principle, then not only do we gain in an understanding of Aristotle's own philosophy, but we also arrive at the only point from which, if at all, we may be able to tread the path in the reverse direction, and unthread fact from principle in those cases where the fact can be known only, or partly, from Aristotle's criticism of it.

(iii)

In this instance, the nature of Aristotle's criticism can be the more easily understood, because we have independent access to what I have been calling the 'facts'.

I shall note again later, in my study of Theophrastus' criticisms of Plato's theory, that there is a shift of interest between speed and difficulty or ease of movement as between Plato and Aristotle.¹²

¹² Pp. 248-52 below.

1. The primary criterion of weight peculiar to Plato's later analysis—as distinct from the criteria of number and movement, which the later passage shares with Plato's earlier account—is the ease or difficulty with which we can move a quantity of earth or fire away from its 'parent body'.

2. For Aristotle, the primary criterion of difference between the parts of a single element that is heavy or light—as distinct from displacement which is the primary criterion for determining which element is heavy and which is light—lies in the speed with which a larger or smaller quantity returns to its natural place.

We can, however, arrive at a closer approximation of these two criteria.

1. At one point in the analysis of resistance in the *Timaeus*, Plato introduces speed alongside ease of movement. The smaller quantity of earth will be easier to drag away from the centre than the larger quantity, and 'it will follow the sooner' (πρότερον συνέπεται, 63D2).

2. In the *De caelo* Aristotle writes, in his first criticism of Plato, quoted at the head of this section (iv 2, 308b12ff.), that not only will the larger portion of fire move towards the circumference more quickly (308b18-19), but that the smaller quantity will move 'from above to below', i.e. from circumference to centre, more quickly, while the larger quantity will move more slowly (b19-21).

In the *first* passage Plato is drawn to write of movement in a way that implies speed: the smaller quantity of earth will be easier to move, and so it will follow the force exerted upon it 'earlier' or 'sooner', and so the more quickly.¹³

The significance of the *second* passage is that Aristotle is here drawn in to describing not the natural movement of fire, which is the regular term of reference in the expression of his own philosophy, but movement of fire that can be the result only of constraint, and so which coincides precisely with the circumstance which Plato takes for the expression of his theory, where movement by constraint is the regular term of reference.

In Aristotle's usual expression of his theory, a larger quantity of fire or of earth will move *towards* its natural place *more quickly*.¹⁴ For 'unnatural' movement this criterion is reversed. The larger quantity of fire, Aristotle

¹³ The uniqueness of this implied reference to speed in Plato's account might be taken as a reason, but not a sufficient reason, for August F. Lindau's deletion of πρότερον, *Novum in Platonis 'Timaeum' ... specimen* (Vratislaviae ad Viadrum, 1815) 38, repeated in his edition (Lipsiae, 1828) 99 (notes). Earlier, Lindau had thought to improve the passage by reading ῥᾶτον <ῥν>, *Ad F.L. Heindorfium ... epistola critica* (Berolini, 1803) 29.

¹⁴ E.g. *De caelo* iv 4, 311a21.

tells us in his criticism of Plato (308b19-21), will move *away from* its natural place *more slowly*.

We arrive therefore at an almost complete coincidence between the phenomena which the two theories purport to describe.

1. For Plato, the smaller quantity of earth will be easier to move away from the centre, and will move the more quickly, while the larger quantity is more difficult to move and, we may infer, will move the more slowly.

2. For Aristotle, a smaller quantity of fire will move away from the circumference more quickly, while the larger quantity will move away more slowly.

If, in order to arrive at a direct comparison with Aristotle's theory, we transfer to the measurement of fire at the circumference the rule which Plato applies to the behaviour of earth at the centre, then both for Plato and for Aristotle it will be true that a smaller quantity of fire will move (or be moved) away from the circumference more quickly, and the larger quantity more slowly.

And in that case, the facts in the two theories are the same. It is the description, or the explanation, of the facts that differs.

1. For Plato, the quantity of either element, fire or earth, is heavier which we have more difficulty in moving away from its parent body, and which therefore moves away from its parent body more slowly. It is more difficult to move the larger quantity of fire; the larger quantity of fire is therefore *heavier*.

2. But for Aristotle the larger quantity of fire is *lighter*, both because it moves more quickly towards its natural place, and because it moves more slowly away from it.

Thus for Plato the larger quantity of fire is *heavier*, while for Aristotle the larger quantity of fire is *lighter*, although both Aristotle and Plato agree on the 'facts': for Plato as for Aristotle, the larger quantity of fire moves, or is moved, more slowly away from the circumference, and the smaller quantity moves, or is moved, more quickly.¹⁵

¹⁵ There will be the same conflict in the analysis of direction. Plato's imaginary observer at the circumference weighs a larger and a smaller quantity of fire: the larger quantity moves centrifugally, i.e. towards its parent element, and is reckoned as moving 'downwards'; the smaller quantity moves centripetally, i.e. away from its parent element, and is reckoned as moving 'upwards'. But for Aristotle fire which moves centrifugally, i.e. towards the circumference, is moving 'upwards', and fire which moves centripetally, i.e. away from the circumference, is moving 'downwards'. Thus the larger quantity of fire, moving towards the circumference, is reckoned by Plato as *heavier* and as moving *downwards*, by Aristotle as *lighter* and as moving *upwards*.

(iv)

When therefore Aristotle writes, in the criticism I have quoted, that if fire is light because it has few triangles, then a larger quantity of fire will have more triangles and will be 'heavier' (βαρύτερον; iv 2, 308b17), he is taking the same word as in Plato; but he is giving it the meaning which it has in his own system.

For Aristotle claims that if the larger quantity of fire is 'heavier' then it must move towards the circumference more slowly (308b16-17). But in fact, Aristotle argues, the opposite is the case: the larger quantity of fire will move towards the circumference more quickly, and away from the circumference more slowly (308b18-21).

The 'fact' which Aristotle asserts here is not denied by Plato: for Plato, as for Aristotle, the larger quantity of fire does in fact travel away from the circumference more slowly. What differs is the description of this fact: Plato describes the larger quantity of fire as being 'heavier' therefore, while for Aristotle the larger quantity of fire is 'lighter'.

However, by taking the word that is used by Plato, but by giving it the sense which it has in his *own* philosophy, Aristotle is led to attribute to Plato the *opposite* of what Plato in fact held to be the case.

For when Aristotle charges Plato with making a larger quantity of fire 'heavier' than a smaller quantity, he claims that in Plato's system the larger quantity, in being 'heavier', would travel towards the circumference more slowly, or with greater difficulty, than a smaller quantity, iv 2, 308b15-18:

'Consequently, it cannot be the case that fire by nature travels upwards because of the small number of triangles ... For in that case the larger quantity, since it has more triangles, would travel <upwards> less readily and would be heavier.'

It is, of course, because Aristotle reckons the natural movement of fire as movement 'upwards', that he counts the *faster* movement of the larger quantity *towards* the circumference and the *slower* movement of the larger quantity *away* from the circumference as both alike evidence that fire is light absolutely and lighter therefore in the larger quantity. For earth, the reasoning is reversed: the larger quantity of earth, like the larger quantity of fire, moves more quickly towards its natural place and, we may infer, more slowly away from it; but since the natural place of earth is the centre, and since movement towards the centre is movement 'downwards', the behaviour of earth proves that earth is heavy absolutely, and heavier therefore in the larger quantity.

As I shall explain in my third and fourth essays, speed of movement is for Aristotle a *secondary* criterion of weight, at least for the 'extreme' elements, earth and fire, in so far as the difference of speed shows only that different quantities of earth are more heavy or less so, and that different quantities of fire are more light or less so. The initial distinction between heavy and light, for the two extreme elements, is determined not by speed, but by displacement. See further, pp. 262-3 below, and cf. p. 212 n. 23 below.

To this hypothesis, Aristotle opposes what he sees as the true state of affairs, that the larger quantity in fact travels more easily, or at least more quickly, towards the circumference, and more slowly away from it, 308b18-21:

'But in the world as we see it now, just the opposite turns out to be the case. The more <fire> there may be, the lighter it is, and the more quickly it travels upwards. And <conversely> for the journey from above to below: the small quantity of fire travels more quickly; the large quantity, more slowly.'

In this way, we arrive at the situation where Aristotle repeats as a refutation of Plato's theory precisely the fact which Plato would have himself admitted: that a larger quantity of fire travels more slowly, or with more difficulty, away from the circumference, while the smaller quantity moves away from the circumference more easily and more quickly.

For if we transfer to the calculation of fire at the circumference the formula which Plato uses of earth at the centre, then it will be true, for Plato as for Aristotle, that the smaller quantity of fire will move away from the circumference more quickly (*cf.* πρότερον συνέπεται, 63D2).¹⁶

(v)

It is important, I think, that our reaction to the apparent fickleness of this argument should not be simply—or at all—one of disappointment or dismay, if we are to appreciate aright the orientation of interest in Aristotle's style of criticism generally, and in particular his criticism of Plato in the *De caelo*. For this first criticism which Aristotle makes of Plato is not a mere sleight of hand.

Aristotle is able to ignore the distinction, between the two senses of 'heavier', in part I have suggested because it is obscured by Plato's own

¹⁶ I have restricted the point where Plato and Aristotle agree to the movement of fire away from the circumference, since this requires the least possible adaptation of Plato's theory. Plato writes that the smaller quantity of earth moves away from the centre more quickly (πρότερον, 63D2). I have concluded that the same will be true of fire: the smaller quantity will move more quickly away from the circumference.

It would of course be possible to argue that for Plato the larger quantity of fire should therefore move *towards* the circumference more quickly, precisely as in Aristotle's theory, and that therefore even the preliminary move in Aristotle's criticism, his assertion that, on Plato's theory, the larger quantity of fire would be *less* inclined to move towards the circumference (308b17), is already in direct conflict with Plato's intention. While not wishing to dispute this, I have preferred not to extend the criterion of speed in Plato's theory to include the 'natural' movement of an element (fire towards the circumference, earth towards the centre), at this stage in my analysis. A more complete 'concordance' between the two theories, of Plato and of Aristotle, will be needed for an understanding of Theophrastus' criticisms of Plato: see below pp. 248-50.

terminology, but fundamentally because of the comparison, and contrast, afforded with his own system by Plato's theory of elemental particles.

In Aristotle's own theory, the *prima materia*, which is a necessary prerequisite for the transmutation of the elements, is not itself characterised as heavy or light. Heaviness and lightness are characters which appear in the production of earth and of fire; and it is from the heaviness of earth and the lightness of fire—and from the relative weight of air and of water—that other secondary substances, formed from the elements, acquire their own distinctive characterisation as in part heavy and in part light.

But according to Plato, at least as seen by Aristotle, the primary particles, from which the four cosmic elements are formed, themselves have weight, and since they are identical in kind and in size—leaving aside, for this purpose, the discrepancy between the triangles that constitute earth and those that constitute the other three elements—Aristotle infers that they have all the same weight.

The weight of any substance formed from the primary particles, which will include the four cosmic elements, can therefore be determined only by the number of particles, as Plato indeed says that it is.

But from this it follows, according to Aristotelean principles, that these secondary substances, including the four cosmic elements, cannot be distinguished as heavy and light, and cannot have movement in different directions.

They could do so, only if they were formed either from a *prima materia* which was itself without weight, or from substances that differed in weight, and were some of them heavy and some of them light, as are earth and fire in Aristotle's own system.

If, instead, the cosmic elements are formed from substances that are identical in kind and in weight, as in Aristotle's eyes Plato's triangles must be, then they cannot exhibit differences of weight as between heavy and light, nor therefore can they exhibit movement in different directions.

The point is that, on Aristotelean principles, different directions of movement—i.e. of natural movement—can arise only from differences of weight, as between heavy and light. They cannot arise subsequently to, or independently of, the determination of weight.

But for Plato the triangles of earth—or of water—and of fire already have weight, and it is only their arrangement to form different primary solids that determines their characterisation as earth—or water—and fire, and their movement therefore to different regions of the universe.

But for Aristotle this is all too late, as it were. If the triangles have weight, and weight of only one kind, then the substances that are formed from them cannot have differences of weight, they can have only different degrees of the same kind of weight, i.e. they cannot be distinguished as heavy and light, they can be distinguished only as more heavy, and less so, or conceivably as more light, and less so. Nor therefore can they have movement in different directions: they must move all in the same direction, with only different degrees of readiness or—more precisely—with different degrees of speed.

From this it follows that Plato's description of the larger quantity of fire, no less than of the larger quantity of earth, as 'heavier' is not, in Aristotle's eyes, a mere difference of nomenclature. By his choice of vocabulary Plato accurately reflects what Aristotle would see as in any case the necessary consequence of Plato's choice of triangles as a single *prima materia*, endowed therefore with a single kind of weight.

Not only, therefore, would it have to follow on Plato's theory—as viewed by Aristotle—that the larger quantity of earth *or* of fire is the heavier; Plato himself admits as much.

This is the reason why Aristotle takes seriously, so to speak, Plato's description of the larger quantity of fire as the heavier. It is *said* to be heavier; and on the principles of Plato's own theory it *must* be heavier.

Since on Plato's theory the larger quantity of fire both is *said* to be heavier, and *must* be heavier, it therefore follows, for Aristotle, that it will move more quickly away from the circumference, and will move, or be moved, more slowly towards the circumference. The point that Plato would agree with Aristotle that this is *not* what happens becomes—within the context that I have outlined—irrelevant.¹⁷

¹⁷ The same qualification is needed here as at the end of my preceding sub-section (p. 206 n. 16 above): for Plato, the larger quantity of fire moves *more slowly* away from the circumference; the speed with which fire would move towards the circumference in Plato's theory (as seen by Aristotle or by Theophrastus), is still incidental to my analysis.

From the present point of view, we see why Aristotle has chosen as his counter-example to Plato's theory the behaviour of different quantities of fire. In the comparison between different quantities of earth, Plato and Aristotle would agree both on the 'facts' and on the description that should be given of them. The larger quantity of earth moves away from the centre more slowly and (for Aristotle) towards the centre more quickly: for Plato, as for Aristotle, the larger quantity is therefore 'heavier'. For the equivalent point in Theophrastus' more complex criticism, see p. 274 below.

We can already foresee here the point which I will develop in more detail later (pp. 239ff. below). For Taylor and for Cherniss, 'facts' and 'description' would be the same, *not only* in Plato's account of earth, but *no less* in Plato's account of fire; for Taylor and Cherniss believe that, measured at the centre, fire in Plato's theory would be lighter in the larger quantity, and would presumably therefore move away from the centre more quickly, precisely as in Aristotle's theory (for Taylor's interpretation, see pp. 45ff. above and *cf.* p. 269 n. 4 below; for the ambiguity in Cherniss' adoption of Taylor's interpretation, *cf.* pp. 179-80 above). We find here therefore the paradox I noted in my Introduction (vol.

(vi)

I conclude that Aristotle's criticism of Plato throughout the fourth book of the *De caelo*, and in particular his conjunction of Plato and of Democritus, results from a number of distinguishable, but convergent, considerations.

In his criticism of Plato's theory of weight, Aristotle ignores Plato's account of the different directions in which fire and earth are said to move, and reduces Plato's theory to a simple equivalence of weight with number.

On the simplest level, Aristotle is able to do this because his own conception of the *sensibilia* does not give the same importance to the intervention of the percipient, and the calculation therefore of resistance.

On a less superficial level, Aristotle is enabled to treat Plato's theory as he does, because Plato does himself speak of a larger quantity of fire, and of earth, as moving 'downwards' and as being 'heavier' than a smaller quantity of either element respectively.

By this word Plato does not mean what Aristotle's criticism forces him to mean: that the larger quantity of fire will move towards the circumference less readily, or more slowly, than the smaller quantity. For Plato believes, as Aristotle also does, that the larger quantity of fire will move, or be moved, *away from* the circumference more slowly.

Aristotle ignores this identity of fact, and exploits the discrepancy of vocabulary, in part because the distinction that Plato's use of 'heavy' and 'light' is founded upon, whereby the circumference and the centre are alike treated as 'down' and as 'up', in relation to different elements, is contrary, so Aristotle believes, both to the facts of the universe, and to the truth universally recognised by common consent, whereby the circumference is 'up' for either element.

At the same time, Aristotle's refusal to adapt himself to, or to make allowances for, Plato's terminology is not merely captious. Plato's 'ec-centric' terminology only symptomises the deeper error: that the differences between the elements in the universe, and particularly between earth and fire, characterised as they are by absolute heaviness and by absolute lightness, cannot be derived, as Plato thinks they are, from a common source, which has only a single kind of weight.

The point is that if the triangles all have weight, then a larger quantity of fire will indeed be heavier than a smaller quantity—if we assume the

i, esp. pp. xv-xvi): Taylor's interpretation of Plato is in large part made up from ideas which belong, not to Plato, but to Aristotle, with the consequence that Aristotle's criticisms of Plato are impossible to understand, since in order to criticise the supposedly Platonic ideas which Taylor's interpretation would place before him, Aristotle would have to renege beliefs which he himself holds to be true. See also the footnote following this.

weight of the triangles to be expressed as heaviness and not as lightness—not however in Plato’s perverse sense of ‘heavier’, but in what is for Aristotle the true meaning of that word: the larger quantity of fire will necessarily travel to the circumference more slowly than the smaller quantity.

All the criticisms that I have quoted spring from this central conviction. Plato’s own terminology has, all unwittingly as it were, played into Aristotle’s hands. A larger quantity of fire is heavier, in Plato’s theory, than a smaller quantity, as Plato indeed says that it is, and fire or air in a certain quantity will, on the same principles, be heavier, Aristotle supposes, than earth or water, because the elements are constructed all from a single material principle, which itself has weight, and where quantity or number can therefore be the only *differentia* of heavy and light.¹⁸

§ 3. AN ACHILLES’ HEEL

So far, I have presented only those features in Aristotle’s own ways of thinking that seem to me to have drawn him away from any more specific consideration of the principles peculiar to Plato’s analysis of weight in terms of resistance, and that have led him to consider heavy and light, in Plato’s system, as dependent solely upon the number of primary particles.

There is also an obvious weakness in Plato’s own theory—if ‘weakness’ is not too unhistorical and evaluative a word—which I suspect will have served to direct Aristotle’s attention to the earlier theory.

¹⁸ To clarify Aristotle’s general intention, I anticipate here the result of the comparison that Aristotle makes between air and water in his criticism of Plato’s theory: iv 2, 308b21-8, see the section immediately following. The comparison of fire and earth is implied in the comparison between opposite forms of absolute weight: iv 2, 309b33-4, and iv 5, 312b20-8; cf. pp. 196-7 above. The comparison of air and earth, iv 5, 312b28-31, cf. p. 197 above. There is no explicit comparison of fire and water, but presumably the same principles would apply.

It is interesting to note the complete misunderstanding of Aristotle’s criticism, not only in Cherniss, but in earlier writers as well. I have already quoted Guthrie’s note (p. 200 above). Archer-Hind writes in a similar vein, though more specifically, *Timaeus* edn 229 (cf. vol. i pp. xv-xvi): ‘Aristotle in his criticism of Plato’s theory ... simply ignores the whole point of it from beginning to end ... Aristotle actually urges the fact that a larger body of flame has a stronger upward tendency than a smaller as an objection to Plato’s theory; whereas it is precisely what Plato affirms must, on his principles, inevitably be the case.’ So near, and yet so very far. Archer-Hind’s formulation errs on the very point which is essential to an understanding of Aristotle’s criticism. Plato does not claim that the ‘larger body of flame has a stronger upward tendency’. On the contrary, Plato’s belief is that the larger quantity of fire is to be reckoned as moving *downwards* and as being *heavier*, and it is precisely this terminology which plays into Aristotle’s hands, and allows him to attribute to Plato the opposite of what Plato in fact believed to be the case.

(i)

In his preliminary account of Plato's theory, in book four of the *De caelo*, Aristotle writes specifically that Plato's theory of equal primary particles is intended to explain both how the larger quantity of lead or copper is the heavier, and how it is that lead is heavier than wood.¹⁹

In his initial criticism of Plato's theory, Aristotle compares different quantities of the same element, and argues that, on Plato's theory, the larger quantity of fire would have to be 'heavier' than a smaller quantity.²⁰ However, in the sentences which follow, the same principles are applied not to the comparison of different quantities of the same element, but equally to the comparison of different elements, as had already been done, by implication, in the criticism of the third book.²¹ A large quantity of air will contain more triangles than a small quantity of water, and on Plato's theory, according to Aristotle, it will therefore be heavier. But in fact, Aristotle argues, a large quantity of air is lighter than a smaller quantity, and lighter also than any quantity of water, in so far as air will always move upwards out of water.

Aristotle writes, *De caelo* iv 2, 308b21-8: πρὸς δὲ τοῦτοις, ἐπεὶ τὸ μὲν ἐλάσσω ἔχον τὰ ὁμογενῇ κουφότερον εἶναι φασι, τὸ δὲ πλείω βαρύτερον, ἀέρα δὲ καὶ ὕδωρ καὶ πῦρ ἐκ τῶν αὐτῶν εἶναι τριγώνων, ἀλλὰ διαφέρειν ὀλιγότῃ καὶ πλήθει, διὸ τὸ μὲν αὐτῶν εἶναι κουφότερον τὸ δὲ βαρύτερον, ἔσται τι πλῆθος ἀέρος ὃ βαρύτερον ὕδατος ἔσται. συμβαίνει δὲ πᾶν τούναντίον· αἰεὶ τε γὰρ ὁ πλείων ἀήρ ἄνω φέρεται μᾶλλον, καὶ ὅλως ὅτιοῦν μέρος ἀέρος ἄνω φέρεται ἐκ τοῦ ὕδατος.

I paraphrase:

'A further argument. Since they claim that the body with the fewer parts of like kind is lighter, and the body with a larger number of like parts is heavier, and since they further claim that air and water and fire are made out of identical triangles, but differ in having a small or a large number of them, which is why one body is lighter and the other heavier, it will follow that there will be a certain quantity of air which is heavier than water.

It is not Aristotle who 'simply ignores the whole point' of Plato's theory 'from beginning to end', but Archer-Hind himself. For it is Archer-Hind who attributes to Plato ideas which he has taken, not from the text of the *Timaeus*, but from his (or Martin's) memories of the *De caelo*. Aristotle, not Plato, believes that the 'larger body of flame has a stronger upward tendency' and is lighter; Plato, on the contrary, believes that measured at the circumference (and even measured at the centre, if we extend Plato's theory to include that circumstance) the larger quantity of fire moves downwards and is heavy. Inevitably therefore Aristotle's criticisms of Plato's theory seem to Archer-Hind to miss the point: the theory which Archer-Hind lays before Aristotle, as allegedly taken from the *Timaeus*, is Aristotle's own theory, whereas Aristotle's criticisms (not unnaturally) are designed to point out the difference between Plato's theory and his own.

¹⁹ *De caelo* iv 2, 308b3-12, cf. pp. 85-7 and 176-7 above.

²⁰ *De caelo* iv 2, 308b12-21.

²¹ *De caelo* iii 1, 299b31-300a7, see pp. 193-6 above.

'But the truth is just the opposite. The larger quantity of air invariably travels upwards more readily <than the smaller quantity, and therefore the larger quantity is lighter>, and in general any quantity at all of air travels upwards out of water <which proves that air is lighter than water>.'

(ii)

The immediate lesson to be drawn from this passage is not essentially different from the lesson already drawn from the comparison between quantities of fire (*De caelo* iv 2, 308b12-21).²²

In the present passage, Aristotle concludes from Plato's definition of weight by number that there will be a certain quantity of air (a large quantity) which will have more triangles, and which will therefore be 'heavier', than some (smaller) quantity of water (308b21-6).

The implication is that the word 'heavier' will have the meaning which it would have in Aristotle's own philosophy, and that the element which is 'heavier' (air) will therefore move 'downwards', i.e. towards the centre, and will do so more quickly in the larger quantity.

To this implied conclusion, Aristotle opposes the 'facts': that air moves upwards more quickly in the larger quantity, and that any quantity at all of air moves upwards out of water. As with the measurement of fire (*cf.* 308b18-21), Plato's theory therefore again stands in contradiction to the 'facts' (*cf.* 308b26-8).

But as with the account of fire, Plato would not have denied the 'facts'. It is true, Plato does not spell out the consequences for his theory of the comparison between air and water, or between different quantities of air. But the principle would presumably be the same: the larger quantity of air would be more difficult to move away from its parent body, and in that sense would be 'heavier' therefore. But Plato would have had no reason to deny that air, in water, moves towards its own region, nor even that it will do so more quickly in the larger quantity. His description of that phenomenon would have differed from Aristotle's (in moving towards its parent body, air would be moving 'downwards', and not 'upwards', as in Aristotle's description of the movement of air in water); but the 'facts' in the two theories would have been (or could have been, if Plato had troubled to work them out) the same.²³

²² Pp. 199-210 above.

²³ There are in fact a number of complications in the comparison between air and water (308b21-8) which do not apply to the comparison between different quantities of fire (308b12-21); these, however, I am leaving for study in my later volumes, as they lead directly to the difficulties which Aristotle faces in establishing a definition of relative weight, for air and water, in his own philosophy. For the moment, we need note only the obvious difficulty that, in order to make Plato's theory yield a description contrary to the 'facts', Aristotle has to conclude that there will be 'a certain quantity of air which will be

(iii)

However, my present interest is to note that in this argument (308b21-8) Aristotle employs not only the comparison between different quantities of the same element (a larger and a smaller quantity of air), but also the comparison between different elements (air and water).

From this point on, Aristotle's criticisms of the Platonic theory, throughout the fourth book of the *De caelo*, are concerned exclusively with the comparison of different elements.

1. Thus in this first passage air, in a certain quantity, will have to be heavier, on Plato's theory, than water in a certain quantity.

2. Later we are told that fire and earth cannot be distinguished, on Plato's theory, as absolutely light and as absolutely heavy.

3. Finally, air, in a certain quantity, will have to be heavier, on Plato's theory, than earth in a certain quantity.²⁴

The range of examples, which embraces the comparison between elements with relative weight, between elements with absolute weight, and between an element with relative weight and an element with absolute weight, is not, I think, accidental. The reasons for it will figure largely in the analysis which I shall give of Aristotle's own theory in my third and fourth volumes. But the only point which is immediately relevant is that in these criticisms Aristotle compares not different quantities

heavier than water' (cf. 308b25-6). In the context, this must mean a quantity of air which is larger than a quantity of water; but in that case how do we measure air in water: the larger quantity within the smaller? Aristotle's 'reply' to Plato therefore abandons the comparison of quantity for the measurement of air in water (hence the reply that 'any quantity at all' of air will move upwards out of water, 308b28), and in fact retains the comparison of quantities only for the comparison of air with air (the larger quantity of air will move upwards more quickly, 308b27).

Even for the comparison of air with air one crucial qualification is needed. When Aristotle writes that 'the larger quantity of air invariably travels upwards more readily' (308b27), he does not mean, as Taylor will take him to mean, that air therefore is light absolutely. The upward movement of air is understood to be limited to its behaviour in water or earth; for when Aristotle comes to spell out the details of his own theory he will tell us specifically that *in fire* air will travel downwards, and will be heavy therefore, from which we may infer that it will be heavier in the larger quantity, as it is (according to Aristotle) in Plato's theory. Aristotle cites here only the upward movement of air, the movement of air therefore *in earth or water*, because it is in either of these two elements that air is shown to be lighter in the larger quantity, *contrary* to Plato's theory. For the details of Aristotle's own theory, see *De caelo* iv 4, esp. 311a22-9 and b4-9. For Taylor's misunderstanding of Aristotle's theory (*apud* Stratton, 217), see further p. 242 n. 22 and p. 275 n. 8 below.

²⁴ The comparison of air and water: *De caelo* iv 2, 308b21-8. The comparison of fire and earth is implied in the comparison between opposite forms of absolute weight: iv 2, 309b33-4, and iv 5, 312b20-8. The comparison of air and earth: iv 5, 312b28-31. For the comparisons of fire and earth and of air and earth, see above pp. 196-7.

of the same element, as in his opening criticism, but different quantities of more than one element.

This comparison of different elements is clearly essential, if Aristotle is to demonstrate that neither Platonic triangles nor Democritean atoms are able to explain the differentiation in weight between the four cosmic elements, which Aristotle holds to be a visible and essential feature of the cosmos.

(iv)

To return to Plato. I have already noted that in Plato's earlier theory, where weight is defined by number, we compare different elements, in the designation of fire as the 'lightest' element, and different quantities of the same element, or of virtually the same element, as in the comparison of copper and gold. By contrast, in the later theory, where weight is defined in terms of resistance, the comparison lies solely between different quantities of the same element.

From this point of view, there is a lacuna, or at least an imbalance, in Plato's two theories. On the interpretation of Plato's theory that I have offered, number as a criterion or as a determinant of weight embraces the comparison of different quantities of the same element as well as the comparison of different elements. On the other hand, weight defined by resistance embraces only the comparison of different quantities of the same element, and not, or at least not in any direct way, the comparison of different elements.

This, finally, explains why it is that Aristotle is led to ignore Plato's account of resistance, and to seize solely upon the definition of weight in terms of the number of triangles.

Aristotle must take the earlier theory as the target of his criticism, if he means to show that for Plato, as also for Democritus, fire or air in certain quantities would have to be heavier than water or earth in certain quantities. For it is only the theory of weight as defined by number that includes both the comparison of different elements, and the comparison of different quantities of the same element. The later theory compares only different quantities of the same element, and fails to offer, in any easily recognisable form, a comparison between the weight of different elements.

(v)

In the passage from his study that I quoted earlier, Solmsen writes that the analysis of weight in terms of resistance 'is by every criterion the most serious and sustained'.²⁵

²⁵ *Aristotle's system* 280 n. 19: cf. above pp. 157-9.

From one point of view, this is perhaps true enough. Plato does intend his later theory, or so I have argued, to include the two features of his earlier definition, where weight is associated with movement, and is defined by number. But from the point of view that I have now indicated it is the *later* theory which is the less complete of the two. For the account of weight as determined by resistance caters only for the comparison of different quantities of the same element; it cannot—or at least it cannot easily—be made to include the comparison of different elements.

Inevitably, therefore, Aristotle's criticism attaches itself to Plato's *earlier* theory, for only so can Aristotle employ against Plato, no less than against Democritus, the arguments which exploit the comparison between different elements, in order to show that no theory which seeks to differentiate the elements by the size or by the number of their constituents can hope to achieve, as Aristotle's own theory claims to do, a separate and inviolable specification of weight for each of the four cosmic elements.²⁶

²⁶ The point I make here will be clearer in the light of my critique of Plato's theory as a whole, and especially when I come to consider the relation between weight and movement in Plato's theory, see ch. XV §§ 5-6, pp. 304-16, esp. pp. 313ff. below. In Plato's *earlier* theory, the difference in direction of movement is associated with the difference in weight between different elements, but it is ancillary to the definition that Plato there offers of weight by number. In the *later* theory, the opposition between fire and earth is determined, or so I shall argue, exclusively by their movement in different directions; but this distinction is not expressed by the terms 'heavy' and 'light', which now attach solely to the comparison between different quantities of the same element. In *either* case therefore Aristotle is able to ignore the difference in movement between the elements, and to take the difference of quantity or number as the sole criterion of weight in Plato's theory. For in the earlier theory movement is not an integral part of Plato's conception; while in the later theory the difference in direction of movement is essential to the 'opposition' between the elements, but is not itself characterised as a difference of 'heavy' and 'light'.

CHAPTER ELEVEN

THEOPHRASTUS: EXEGESIS AND CRITICISM

§ 1. TAYLOR'S INTERPRETATION

(i)

In the *De sensibus* Theophrastus summarises Plato's theory of weight (cap. 83) and then criticises it at some length (capp. 88-9). With the analysis of these two passages from Theophrastus, we arrive at perhaps the most important part of my study.¹

Rightly understood, Theophrastus' remarks serve, I believe, only to confirm the interpretation that I have offered of Plato's own theory, and of the principles that underlie, and determine, Aristotle's criticism of it. Wrongly understood, Theophrastus' criticism has, I suspect, lain at the root of that series of misinterpretations that stems from, and centres upon, Taylor's interpretation.

Thus earlier I restricted my analysis of Taylor's interpretation to a close examination of the text of the *Timaeus*, and of one or two obvious passages in Aristotle. But there exists also a lengthy commentary by Taylor on the whole of Theophrastus' criticism of Plato's theory of weight, transcribed by Stratton in the notes to his translation of Theophrastus' *De sensibus*.² In this commentary, Taylor takes for granted, and seeks to exemplify, the interpretation of Plato's account of weight as defined by resistance which he was to publish some ten years later in his voluminous *Commentary on Plato's 'Timaeus'*.³

Earlier, I suggested that this interpretation had resulted from an unthinking Aristoteleanisation of the lacunae in Plato's theory, or at least in Plato's expression of his theory, and in particular from a misunderstanding of what I earlier called 'the alignment of opposites'.⁴ At the same time, I suspect that the origins of Taylor's interpretation are in fact to be found in the notes on Theophrastus that he had sent to Professor Stratton in America some ten years earlier.

¹ The text of the two passages is quoted as required by each part of my analysis. My paraphrase of the whole is given at the end of my chapters on Theophrastus, pp. 277-9 below.

² George M. S. Stratton, *Theophrastus and the Greek physiological psychology before Aristotle* (London and New York, 1917) (henceforward simply 'Stratton'), pp. 213-18.

³ Taylor's earlier interpretation is summarised in his *Commentary* 443-4.

⁴ Pp. 46-8 and 51-6 above.

If so, this will confirm the charge I made earlier, that Taylor's interpretation is essentially the result of his Aristotelean conceptions, and preoccupations. For the purpose of Theophrastus' criticism, as we shall see, is in large part to work out the consequences of Plato's theory, within the framework of his own Aristotelean philosophy. Taylor, I shall hope to show, has mistaken *criticism* for *exegesis*. He has thought to see, in what Theophrastus intended as a *refutation* of Plato's theory, an *exposition* of Plato's own ideas. This is a wholly false start, from which Taylor never recovers.

(ii)

But not only has Taylor mistaken criticism for exegesis: his misunderstanding of Theophrastus has resulted also, I believe, from his failure to recognise a shift in direction between Theophrastus' first and second criticism.

Thus in the earlier part of the section of criticism (*Dox.* 526.5-10), Theophrastus does no more, essentially, than repeat, though admittedly in a highly abbreviated form, the principles that I have already sought to uncover in Aristotle's criticism of Plato.

But in the later part of his criticism (*Dox.* 526.10-18), Theophrastus seeks, as it were, to go beyond Aristotle, and to explore the inconsistencies that Aristotle's criticism would lead to in Plato's theory.

This second approach yields a superficial similarity between Theophrastus' criticism and the interpretation of the *Timaeus* adopted by Taylor. Taylor wrongly takes this coincidence as confirmation of his interpretation, failing to recognise both that the inconsistency is intended by Theophrastus as a refutation of Plato's theory, and that in any case the inconsistency has been deliberately fabricated by Theophrastus himself, in the course of his criticism of Plato.

(iii)

In order to unravel this whole tangled skein of mis-assumption and of misinterpretation, Theophrastus' criticism will need to be followed out, stage by stage, in this and in the chapters which follow.

For the moment, however, in this present chapter, I shall do no more than consider the summary which Theophrastus gives of Plato's theory (cap. 83 = *Dox.* 524.26-8), and then the general orientation of the first two sentences of criticism (cap. 88 = *Dox.* 526.5-7), with the interpretation which Taylor gives of them.

For only by a careful correction of the assumptions exemplified in Taylor's opening interpretation of these two sentences can we hope to

read aright the repetition of Aristotle's criticism in the earlier part of Theophrastus' criticism (*Dox.* 526.5-10); while it is only if we have gauged correctly the Aristotelean character of the first part of Theophrastus' criticism that we can hope to disentangle the processes of thought by which, in the later part of his criticism (*Dox.* 526.10-18), Theophrastus seeks to demonstrate the inconsistency in Plato's theory.⁵

§ 2. EXEGESIS

Theophrastus summarises Plato's theory of weight as follows, *De sensibus* 83 (*Dox.* 524.26-8): βαρὺ δὲ καὶ κοῦφον τῷ μὲν ἄνω καὶ κάτω διορίζειν οὐ δεῖν, οὐ γὰρ εἶναι τοιούτων φύσιν· ἀλλὰ κοῦφον μὲν εἶναι τὸ εἰς τὸν παρὰ φύσιν τόπον ῥαδίως ἐλκόμενον, βαρὺ δὲ τὸ χαλεπῶς.

This is fairly straightforward. Theophrastus clearly intends to summarise Plato's later definition, of weight as determined by resistance (*Tim.* 62C3ff.). Thus the two sentences I have quoted clearly correspond to what I called earlier Plato's analysis of direction (62C3-63A6) and Plato's analysis of weight (63A6-E8).⁶

The analysis of direction (62C3-63A6) is summarised in Theophrastus' first sentence:

“‘Heavy’ and ‘light’ should not be defined by ‘up’ and ‘down’, for such things have no nature.”

The analysis of weight (63A6-E8) is summarised in the second sentence:

‘Instead, ‘light’ is what is easily pulled into a region that is contrary to its nature, ‘heavy’ is what is with difficulty < pulled into a region contrary to its nature >.’

(i)

In the first sentence, τῶν τοιούτων looks back to ‘up’ and ‘down’, immediately preceding (and not to ‘heavy’ and ‘light’ at the beginning of the quotation).

The denial that there can be a ‘nature’ of what is ‘up’ and ‘down’ resumes, accurately enough, Plato's initial claim that “‘heavy’ and

⁵ The most recent commentary on this part of the *De sensibus*, and indeed the only detailed commentary that I know of since that of Taylor, is given by J. B. McDiarmid, ‘Plato in Theophrastus’ *De sensibus*, *Phronesis* 4 (1959) 59-70, esp. 66-70. McDiarmid's interpretation merely follows that of Taylor, and in the chapters which follow I have thought it simplest therefore to subsume McDiarmid's interpretation under that of Taylor, and to allow Taylor's interpretation to act as the alternative to my own. See further Note 3, esp. pp. 334-5.

⁶ Cf. p. 4 above.

“light” must be examined in conjunction with the nature that is spoken of as “above” and “below” (62C3-4), and his statement, immediately following, of what I have called the ‘common error’, whereby there would exist ‘by nature two opposite places, “above” and “below” ... , which divide the whole between them’ (62C5-8).

I have already commented on Plato’s use of ‘nature’, whether as noun or verb, in these and in the following sentences of the analysis of direction. Plato will allow that the universe is ‘by nature’ spherical, and that the parts of the circumference are ‘by nature’ equidistant from the centre; but he will not allow that the centre is ‘by nature’ up or down (62D6-8), nor that those terms can rightly be used to describe any part of a spherical universe (*cf.* 63A4-6).⁷

Theophrastus, rightly enough, sees this refutation of the ‘common error’ as the main message to be gleaned from Plato’s analysis of direction.

(ii)

A trifle less satisfactory is Theophrastus’ summary of Plato’s analysis of weight.

Theophrastus rightly sees that Plato’s denial of any existence of ‘up’ or ‘down’ by nature is the necessary negative move towards the positive definition of weight which follows (63A6ff.), and which Theophrastus neatly summarises as based on the ‘difficulty’ or ‘ease’ with which we ‘pull’ or ‘drag’ an element away from the place which is natural to it. Theophrastus’ ἐλκόμενον exactly repeats the verb which Plato had used in his description of the comparison between different quantities of fire (ἐλκων, 63B6) and between different quantities of earth (ἐλκομεν, 63C7-8).

There is however more than a touch of Aristoteleanism in Theophrastus’ then singling out, to describe the direction of movement, the place that is ‘other than’ or ‘contrary to nature’ (τὸν παρὰ φύσιν τόπον).

Admittedly, Plato had used the expression ‘contrary to nature’ in describing the movement of earth (ἐλκομεν εἰς ἀνόμοιον ἀέρα βίᾳ καὶ παρὰ φύσιν, 63C7-8). Theophrastus’ repetition does therefore rather nicely bring out the point that, though Plato will not allow that ‘up’ and ‘down’ exist ‘by nature’, nonetheless he does allow that the movement of an element away from its parent body is ‘contrary to nature’.

On the other hand, what is ‘contrary to nature’ in Plato’s theory is not, as for Aristotle, ‘place’ as such, but rather the movement of an element away from its parent body. It is ‘the journey towards its parent body’ (ἡ

⁷ Cf. pp. 24-5 above. See also Note 9, pp. 391ff. below.

... πρὸς τὸ συγγενές ὁδός, 63E4-5) which, in Plato's final definition, determines that the larger quantity of fire or of earth shall be counted as 'heavy', and the movement away from its parent body which determines that the smaller quantity of either element should be counted as 'light'.⁸

This feature in Plato's definition looks back to the distribution of the elements throughout the cosmos on the principle of 'like to like' (57C2-6). The main masses of each of the elements take up a position which is reserved to that element alone (*cf.* τόπον ἴδιον, 57C3); they are there joined by whatever fresh quantities of that element may be formed from the constant interchange of the geometrical solids, the new particles travelling 'to the place of those bodies to which they are most akin' (πρὸς τὸν ἐκείνων οἷς ἂν ὁμοιωθῇ τόπον, 57C5-6). This is exactly the process which explains the reference in Plato's analysis of weight to 'that place in the universe which the nature of fire has specially taken for its own, and where there would be accumulated the main mass to which fire travels' (*cf.* 63B2-4). It is this same conception which governs the final definition, and which determines that 'heavy' and 'light' are there said to be recognised by their movement towards or away from 'the parent body' (τὸ συγγενές, 63E4-5).

It is true, therefore, that in the *Timaeus* there is very nearly the conception of different places as 'proper' or 'peculiar' to an individual element (*esp.* τόπον ἴδιον, 57C3); but there is not in Plato the deliberate subordination of body to 'place' which will be a distinctive and a crucial feature of Aristotle's philosophy.

There is therefore already a potential distortion in Theophrastus' writing, in his summary of Plato's theory, that 'heavy' and 'light' are defined by Plato with reference to 'the place that is contrary to nature'. The point will be quite simply that for Plato, as will not be the case for Aristotle, place in itself is neutral; it is not place as such, but the presence of the main body of earth and of fire at centre and circumference respectively which is the basis for Plato's definition of 'heavy' and 'light', and of 'up' and 'down'.⁹

⁸ *Cf.* pp. 40-1 above.

⁹ The consequence of this distinction can be seen, for example, in Plato's account of the 'alignment of opposites' (*Tim.* 63D4-E3; *cf.* pp. 35-9 above). For Aristotle, both fire and earth, in moving towards the centre, are moving 'downwards', since direction is determined by the nature of the centre itself as 'down' (e.g. *De caelo* iv 1, 308a29-31). But for Plato the movement of earth towards the centre (and towards its parent body therefore) is movement 'downwards', while the movement of fire in the same direction (but away from its parent body therefore) would be movement 'upwards' (if we agree to include in Plato's theory the calculation of fire at the centre: see *esp.* pp. 56ff. and 62ff. above).

This difference between the Aristotelean and the Platonic doctrine of 'place' will be essential to the criticisms which Theophrastus makes of Plato's theory. Theophrastus will conclude that, for Plato, earth and fire cannot be respectively heavy and light absolutely,

§ 3. CRITICISM

When Theophrastus turns to the criticism of Plato's theory, his first two sentences run as follows, *De sensibus* 88 (*Dox.* 526.5-7): ἔτι δὲ τὸ βαρὺ καὶ κοῦφον οὐχ ἀπλῶς, ἀλλ' ἐπὶ τῶν γεωδῶν ἀφώριξε· τούτων γὰρ δοκεῖ τὸ μὲν βαρὺ χαλεπῶς, τὸ δὲ κοῦφον ῥᾶον ἄγεσθαι πρὸς ἀλλότριον τόπον.

In the first sentence of this criticism, Theophrastus writes that Plato has not defined heavy and light in a simple or absolute sense, but that his definition is restricted to 'substances that are of an earthy nature'. For of such substances, Theophrastus tells us, in the second sentence of his criticism, it is true, or 'does appear', that the quantity which is difficult to bring into a region other than its own is heavy, while a quantity which is easier to move is light. The behaviour of earth therefore corresponds precisely to the definition that Theophrastus had given of Plato's theory, several pages earlier (cap. 83), whereby again what is light is easy to move into a region other than its own, while what is heavy is more difficult to move.

(i)

In his commentary on these two opening sentences of criticism Taylor at once introduces his thesis that, for Plato, earth is heavier than air at the centre, but is lighter than air or fire when measured at the circumference. Thus 'the meaning', Taylor tells us, of Theophrastus' opening two sentences, 'is that Plato bases his definition' on the measurement of earth, in order to show that 'an air-dweller might call air heavy and stones light.' 'This', Taylor adds, 'is a correct account of Plato's reasoning.'¹⁰

I have already explored, in the earlier part of my essay, the two principal errors contained in the interpretation of Plato which Taylor repeats at this point.

but that either element will be heavy or light 'in relation to <its own> place' (cf. *Dox.* 526.13-14). The point will be that Plato has failed to define 'heavy' and 'light' in terms of natural movement towards the centre and towards the circumference, and that Plato's alternative and weaker definition, whereby an element is heavy 'because it is difficult to drag into a region other than its own' can be interpreted in more than one way when an element is measured in relation to a place which is not its own. In Theophrastus' hands, Plato's theory will be left in a limbo, somewhere between the original conception of the *Timaeus*, where weight is defined in terms of the relation of an element to its parent body, and the fully Aristotelean doctrine, where weight is defined in terms of the relation of an element to its 'natural place'. For the working out of this feature of Theophrastus' criticism, see further pp. 255ff. and 259ff. below.

¹⁰ Stratton, 214. The lemma which Taylor has here prefixed to his commentary does not in fact correspond to the translation printed on the previous page, but it is reasonably clear from the content of his remarks that Taylor means to explain the opening two sentences of Theophrastus' criticism (*Dox.* 526.5-7).

1. The comparison of *different* elements does not occur in Plato's account of weight as defined by resistance.

Moreover, a comparison of different elements cannot, I have argued, be in any way directly implied by the conception that Plato has of the kind of resistance which determines the calculation of weight.

2. Even in the comparison between different parts of the *same* element Plato does not say that a quantity of earth would be light at the circumference.

Plato does not in fact speak of earth measured at the circumference at all. If he does intend us to extend his theory to include this circumstance, then his intention cannot be, I have argued, that the larger quantity of earth, which is heavier when measured at the centre, would be lighter if measured at the circumference.¹¹

But not only is Taylor's formulation not 'a correct account of Plato's reasoning': Theophrastus does not say that it is. Indeed, at this point in his criticism, Theophrastus does not voice Taylor's formulation at all. Theophrastus tells us that, on Plato's definition, what is heavy is difficult to move into a region other than its own, while what is light is easier to move, and that this is true, or 'does appear to apply' (*δοκεῖ*), to earthy substances. There is, at least so far, no indication of any direct comparison between 'earthy substances' and air or fire, nor is there any indication that, if that comparison were made, earth at the circumference would be lighter than fire, the two features which are essential, and peculiar, to Taylor's interpretation.

I quoted earlier parts of Taylor's commentary where he is unable to distinguish what he reads in Plato's text from what he has himself added to it.¹² There is precisely the same weakness in the opening of Taylor's interpretation of Theophrastus. Some words on 'heavy' and 'light' and 'movement' and 'place'—and Taylor is at once himself air-borne, with all the paraphernalia of his own interpretation of Plato's theory trailing gloriously behind him, but with no real thought of where the substance of it all has been taken from.

(ii)

Not only does Theophrastus not repeat Taylor's formulation; even if Taylor's formulation were 'a correct account of Plato's reasoning', is

¹¹ Pp. 45-50 and 56-9 above. In the note I have quoted (Stratton, 214), Taylor compares different elements. In the continuation of Taylor's commentary, there appear the complementary assumptions that measured at the circumference the larger quantity of earth would be lighter (Stratton, 216, 217, 218), and that measured at the centre the larger quantity of fire would be lighter (Stratton, 217).

¹² Pp. 45-50 above.

there any reason why Theophrastus should have repeated it at this point? Why should Theophrastus start his *criticism* with 'a correct account of Plato's reasoning'?

On the most general grounds, it is much more likely that Theophrastus should begin this section of his work with an account of Plato that is intended to be directly critical. For Theophrastus has already given his *précis* of Plato's theory (cap. 83). The present section (capp. 88-9) is devoted to criticism, and there is no need therefore, one would have thought, for Theophrastus to add anything to his account that is merely exegetical.

Obviously Theophrastus might begin with a reminder of what he has already told us is Plato's theory. That in effect is how he begins his criticism of Democritus (cap. 71 = *Dox.* 520.10-11): καίτοι τό γε βαρὺ καὶ κοῦφον ὅταν διορίζῃ τοῖς μεγέθεσιν ...¹³ And there is something of the same purpose in his including a repetition of Plato's definition in the present passage: in the case of earthy substances, 'what is heavy is difficult to move, what is light is easy to move, to a place that is not its own'. But the orientation of this opening remark, its point and purpose, the reader will expect to be in some way critical, and not merely expository.

This expectation is confirmed when precisely the point which Theophrastus makes in his opening sentence—that Plato has failed to define what is heavy or light absolutely, and that his definition applies only to earthy substances—is repeated in the final sentence of Theophrastus' passage of criticism (cap. 89 = *Dox.* 526.16-18). Clearly, the point can be in place there only as a summary of Theophrastus' criticism, and not, or at least not only, as an account of Plato's method of reasoning. Loosely translated, the purpose of Theophrastus' final sentence must be something like:

'Everything goes wrong for Plato (ταῦτα δὲ πάντα συμβαίνει), because he does not define heavy and light absolutely, but only for what is of an earthy nature.'¹⁴

(iii)

But perhaps I have been unfair to Taylor, for he is, I think, at least partly aware of the potential tension between exegesis and criticism in his interpretation of these sentences. For while telling us that Theophrastus offers 'a correct account of Plato's reasoning', Taylor does also tell us that this is intended as a criticism of Plato's theory.

Taylor writes:

¹³ Cf. vol. i pp. 132ff.

¹⁴ For the analysis I will give of this sentence in its context, see below pp. 276-7.

‘Ἀφώριξε cannot mean that’ Plato’s ‘*definition* is acceptable even for stones, because Aristotle and Theophrastus would say that what you mean by calling stones heavy is not that they are hard to move from the earth’s surface but that they naturally move *down*. (Aristotle makes this quite clear in *de Caelo* IV, 2.) The statement which Plato makes about heavy and light earthy bodies they admit to be true, but they do not regard it as a correct *definition*.’¹⁵

The immediate awkwardness in this interpretation is that it is inconsistent with what Taylor has already told us, in this same note, is ‘a correct account of Plato’s reasoning’.

According to Taylor, Plato thinks, and Theophrastus here represents him as thinking, that an earthy body is heavier than fire or air at the centre, but lighter than fire or air when measured at the circumference: ‘an air-dweller might call air heavy and stones light.’ Taylor then tells us that ‘the statement which Plato makes about heavy and light earthy bodies’ Aristotle and Theophrastus ‘admit to be true’. But very nearly the whole point of Aristotle’s theory, and certainly an important feature of it, is precisely that earth, and fire, have each a fixed or absolute weight (heaviness or lightness), wherever they may be. Aristotle and Theophrastus certainly do *not* agree that earth could be heavy in one place and light elsewhere. They cannot therefore possibly ‘admit’ that Plato’s theory—as represented by Taylor—is ‘true’, at least for earth, and inadequate only as ‘a correct *definition*’.

(iv)

But this of course is not what Taylor thinks. The point which Aristotle and Theophrastus ‘admit to be true’, but which they do not recognise as adequate for a definition, is related solely to the measurement of *earth* at the *centre*: namely the banality that ‘stones ... are hard to move from the earth’s surface’.

But the need for this restriction highlights the inconsistency in Taylor’s analysis.

1. In the sentence which I *first* quoted from his note Taylor thinks to find in Theophrastus’ opening two sentences an account of how ‘an air-dweller might call air heavy and stones light’.

2. But in the *continuation* of the same note the statement which Aristotle and Theophrastus ‘admit to be true’ is a statement exclusively about *earthy* bodies, and even so a statement which will apply exclusively to earthy bodies which are measured *at the centre*: ‘stones ... are hard to move from the earth’s surface’.

¹⁵ Stratton, 214-15.

These two theses are radically inconsistent. If Theophrastus intends to describe a feature in the behaviour of earth which Plato and Aristotle would *agree* upon (the *second* point), then he cannot at the same time intend to describe a comparison where earth would be *lighter* than fire (the *first* point).

But Taylor does not recognise the difference between these two points. For here, as in his edition of the *Timaeus* ten years later, Taylor fails to recognise that the *latter* point, the measurement of different quantities of *earth* at the *centre*, in no way implies a comparison between *earth and fire* at the *circumference*, and that *a fortiori* it can in no way imply the more specific conclusion that measured at the circumference stones will be 'light' and that fire, or air, will be 'heavy'.

(v)

But even if we consider only the *second* of Taylor's two theses, his interpretation, it seems to me, is still radically misconceived.

The purpose of Theophrastus' opening sentences, Taylor seems to mean, in the passage I have quoted from the later part of his note, is that Plato set out only or primarily to define earthy substances, and that in doing so he made a statement which Aristotle and Theophrastus recognise as true, but which they regard as inadequate—and this is the only point of criticism—for a definition.

But in fact what Aristotle makes clear in the opening of the chapter of the *De caelo* that Taylor refers to (iv 2), and indeed throughout the fourth book of the *De caelo*, is that earlier theories of heavy and light, including that of Plato, do *not* allow for his own distinction of substances that are heavy and light absolutely, and in particular that earlier thinkers have failed to recognise the existence of a body that is light absolutely.¹⁶

In the *first* part of his opening sentence, Theophrastus repeats precisely this general principle: Plato has not defined heavy and light 'in an absolute sense' (ἀπλῶς).

The *second* part of Theophrastus' opening sentence then fairly obviously means that *instead of* defining heavy and light in an absolute sense, and thereby distinguishing an element which is light absolutely from one which is heavy absolutely, Plato's definition is in fact restricted to *one* kind of substance only, namely 'substances that are made of earth'.

Fairly obviously, it is this *restriction* of Plato's definition to earthy substances which Theophrastus singles out as the fault in Plato's theory,

¹⁶ See the passages quoted in my first volume, vol. i pp. 6-40. For the failure of earlier thinkers to recognise the existence of a body that is light absolutely, see esp. *De caelo* iv 4, 311b14-19 (vol. i pp. 9ff.). I return to this point in my analysis of Aristotle's own theory in volumes three and four.

and not, or at least not primarily, any formal inadequacy of Plato's account, as a definition.¹⁷

(vi)

I conclude that whatever the more precise purport of Theophrastus' opening criticism may be, there is, at least so far, no reason at all for taking it to mean that, on Plato's theory, earth will be heavier than fire when measured at the centre, but lighter when measured at the circumference. This interpretation may—or may not—emerge in the course of Theophrastus' critique. But the opening two sentences do nothing to support Taylor's idiosyncratic interpretation of the relevant pages of the *Timaeus*. Taylor thinks that they do, only because he has taken ἀφώριξε as a description of Plato's procedure, which then at once suggests to him his own interpretation of Plato's conclusions.

As it is, the general positioning of the expression—quite apart from its more specific content—indicates that the clause introduced by ἀφώριξε is intended to be in some way directly critical of Plato.

And in fact, whatever the more specific purport of Theophrastus' criticism may be, the general intention is obvious. Instead of distinguishing two elements with opposite forms of absolute weight, Plato's definition is *restricted* to 'substances of an earthy nature'.

Theophrastus does therefore condemn Plato's definition as false: not however because it is in some way formally deficient, but because it is *restricted* in its scope. The nature of this restriction I consider in the chapter which follows.

¹⁷ Plato and Democritus are in fact explicitly credited, in book four of the *De caelo*, with 'definitions' of heavy and light (e.g. διώρισαν, of the Platonists, iv 2, 308b29; διορίζουσι, of the Atomists, 309a12), as opposed to those, Anaxagoras and Empedocles, who 'gave no definition' (iv 2, 309a19-21). For Plato, see also *De caelo* iii 1, 300a1. I return to this point in my third volume. Cf. p. 3 n. 1 above.

CHAPTER TWELVE

THEOPHRASTUS: THE FALSE DEFINITION

§ 1. 'EARTHY SUBSTANCES'

I turn therefore from the form to the substance of Theophrastus' first criticism.¹ At first sight, and taken in isolation, Theophrastus' restriction of Plato's definition to 'earthy substances' would be very puzzling. After all, the whole burden of Plato's earlier theory, where weight is defined by number, is precisely to establish fire as light, and water as heavy. Plato's later analysis, where weight is determined by resistance, again turns on the difference between fire and earth, at least in so far as they move in opposite directions, fire to the circumference, and earth to the centre.

But in the light of Aristotle's criticism Theophrastus' remark at once falls into place.

(i)

Aristotle's criticism of Plato, I have sought to show, stems from the notion that substances in Plato's world are all of the same kind, since they are all composed of particles with equal weight. From particles which have all the same weight, there cannot, in Aristotle's view, be derived elements with opposite forms of absolute weight. In fact, Aristotle supposes, Plato's triangles produce only substances that have heaviness, and where the larger quantity will be heavier than the smaller quantity. And this coincides with Plato's own assertions, that fire is lightest because it has the smallest number of triangles, and that a larger quantity of earth, or of fire, is 'heavier' than a smaller quantity.²

Thus Plato purports to offer a definition of heavy and light based on, or at least closely attached to, a distinction of place. But he does not recognise the Aristotelean distinction of place, whereby a larger quantity of earth is heavier than a smaller quantity, in that it moves more quickly downwards, while a larger quantity of fire is lighter than a smaller quantity, in that it moves more quickly upwards. For Plato, a larger quantity of earth *or* of fire will be heavier.

Thus Plato's definition—from Aristotle's point of view—covers only *one* kind of substance, a substance where the larger quantity is invariably heavier. In Aristotle's system, this is true *only* of the nature of earth.

¹ *Dox.* 526.5-7; *cf.* p. 221 above.

² See ch. IX-X, esp. ch. X § 1, pp. 192-9 above.

(ii)

The point to appreciate—here as in my analysis of the criticisms which Aristotle makes of Plato—will again be that Plato and Aristotle or Theophrastus do not disagree on the facts of the case, but on the description that is given of them.³

Both Plato and Aristotle—and so presumably also Theophrastus—agree that, for fire no less than for earth, it will be more difficult to drag the larger quantity away from its proper place, or at least that the larger quantity will move, or will be moved, more slowly away from the circumference and away from the centre respectively, and that the smaller quantity will be easier to move, or at least that it will move, or be moved, more quickly. Disagreement centres on the description of this phenomenon.

1. Plato concludes that the quantity which is more difficult to move, whether it is fire *or* earth, is therefore the *heavier*.

2. Theophrastus and Aristotle believe that only the quantity of earth which would move away from the centre more slowly is the heavier, and that the fact that a larger quantity of fire would move away from the circumference more slowly is an indication not that fire is *heavier* in the larger quantity, but that it is *lighter*.

The description of the quantity which is more difficult to move, or which moves more slowly, as 'heavier' is therefore true, for Aristotle and for Theophrastus, *only* of earth. And this therefore is precisely the criticism that Theophrastus first makes of Plato's theory. The description of the quantity which is more difficult to move, or which moves more slowly, as 'heavier' is true *not* of fire *and* earth, as Plato claims: it is true *only* of 'substances that have an earthy nature' (τῶν γεωδῶν).⁴

³ For this distinction in my analysis of Aristotle's criticism, see ch. X § 2 above, esp. pp. 201ff.

⁴ Plato writes of difficulty or ease of movement, and at one point of speed (πρότερον, 63D2); Aristotle writes of speed, and not directly of ease or difficulty of movement. I shall argue later that, in the continuation of his criticism, Theophrastus is willing to adopt either criterion: the quantity which moves more slowly is also the more difficult to move. For the moment, however, I attribute to Theophrastus and to Aristotle 'agreement' with Plato only on the question of speed, although this makes several of my formulations in this sub-section rather cumbersome.

In writing that, for Aristotle and so presumably for Theophrastus, the larger quantity of earth will move away from the centre more slowly, I am applying to earth the rule which Aristotle makes explicit for the behaviour of fire, in his criticism of Plato, *De caelo* iv 2, 308b19-21. On these points see further pp. 248ff. below, and cf. pp. 70-2 and 202-4 above.

(iii)

I return therefore to the relation between Theophrastus' opening two sentences of criticism (cap. 88) and the account that he had given of Plato's theory some chapters previously (cap. 83), and in particular I return to the question: does either passage support Taylor's interpretation, whereby 'an air-dweller might call air heavy and stones light'?

In the earlier account (cap. 83), Theophrastus states that, for Plato, a body which is easier to drag into a region other than its own is light, and that a body which is difficult to move is heavy. This account will correctly represent the comparison, in the *Timaeus*, between different quantities of fire measured at the circumference, and between different quantities of earth measured at the centre: in either case, according to Plato, the larger quantity is more difficult to move and is heavy, the smaller quantity is easier to move and is therefore accounted as light.

In Theophrastus' repetition of Plato's theory there is therefore no implication that earth and fire are compared at the circumference, nor that in this comparison earth—or 'stones'—would be found to be light.

In his opening criticism of Plato's theory (cap. 88), Theophrastus repeats his earlier account of Plato's definition, but with the critical rider that Plato's definition is true only of 'earthy bodies'.

Do we perhaps see here part of the origin of Taylor's belief that earth, for Plato, is measured at the circumference? Does Taylor perhaps somehow imagine that, since Plato's definition, according to Theophrastus, is true only of 'earthy bodies', therefore the observer at the circumference no less than the observer at the centre should be visualised as weighing different quantities of earth, or as somehow comparing earth with fire?

Such an interpretation would be wholly perverse. As I have explained, the point of Theophrastus' criticism will be that the definition which Plato seeks to apply to fire *and* earth, Theophrastus believes is in fact true *only* of earth. For although Theophrastus believes that a larger quantity of fire would indeed be more difficult to drag away from the circumference than a smaller quantity, or at least would move away from the circumference more slowly, this behaviour he sees as proving, not that a larger quantity of fire is heavier than a smaller quantity, but that the larger quantity will be lighter.

The point of Theophrastus' criticism is therefore that Plato has applied to fire the definition which Theophrastus thinks can apply only to earth. There is in this criticism no implication that Plato himself sought to compare earth and fire at the circumference, nor that, if he had done so, he would have thought that earth was light, and fire heavy.

(iv)

I summarise. The basis of Aristotle's complaint against earlier theories of heavy and light is that they do not recognise his own distinction of substances that are heavy and light simply or exclusively. Theophrastus repeats this general criticism.

Against Plato, Aristotle argues in particular that if the elements are all derived from triangles that are equal in weight, then they cannot be characterised by different forms of weight. The elements can be only more heavy, or less so, in so far as they are constituted from a larger, or smaller, number of triangles.

Theophrastus repeats this feature of Aristotle's criticism in the form that Plato's definition of weight applies only to substances that are made of earth, for in Aristotle's system it is true only of earth that the larger quantity is invariably the heavier.

The point will be that instead of distinguishing fire and earth as respectively light absolutely and heavy absolutely, Plato's analysis applies to fire and earth the rule which is in truth applicable only to earth.

§ 2. EXPLOITING A PARADOX

This preliminary, and minimal, orientation enables us to exploit an obvious paradox. Aristotle refers exclusively, or so it would seem, to Plato's earlier theory. Theophrastus seemingly refers exclusively to Plato's later theory.

The account I have given so far of Theophrastus' criticism may seem only to accentuate this paradox. For Theophrastus, or so I have argued, correctly repeats the fundamental charge in Aristotle's criticism of Plato; and yet in his criticism, as in his exegesis, of Plato's theory, Theophrastus refers not, as Aristotle had done, to Plato's definition of weight by number, but to the later account, of weight as defined by resistance.

In fact, I would argue that this paradox is less startling than may at first sight appear, and that, properly understood, it serves only to confirm the interpretation I have given hitherto.

(i)

Theophrastus' whole account of the *sensibilia* in Plato is taken from the analysis of the common and the particular *pathemata*: chapters 83-4 summarise the analysis of the common *pathemata* (61D5-65B3); chapters 84-6

(περὶ δὲ χυμῶν ...) summarise the analysis of the particular *pathemata* (65B4-68D7).⁵

The definition which Theophrastus repeats of heavy and light therefore necessarily corresponds to the later theory of weight as defined by resistance: the sentences transcribed earlier from chapter 83 clearly summarise *Tim.* 62C3-63E8.⁶

To this summary of the later theory, Theophrastus adds (cap. 88), or so I have argued, essentially the criticism which Aristotle makes of the earlier theory. This coupling of the substance of Aristotle's criticism with the definition of weight by resistance is significant, I would argue, for the account that I have already given of Aristotle's criticism of Plato.

(ii)

Aristotle prefaces his criticism of Plato, in both the third and the fourth books of the *De caelo*, with a definition where weight is determined solely by the number of triangles.⁷

In my analysis of Plato's theory, I argued that weight as determined by number was common to both Plato's definitions, of weight as defined by number, and of weight as defined by resistance.⁸

In my account of Aristotle's criticism, I then argued that the features peculiar to Plato's later definition, of weight as defined by resistance, had, for various reasons, been discounted by Aristotle, leaving, in the later theory, *only* the determination of weight by number.⁹

An alternative, and perhaps at first sight a simpler, way of arriving at the same result would be to say that Aristotle simply disregards the later theory altogether, and takes the earlier theory as the sole target of his criticism.

I have been reluctant to adopt this approach for two reasons. First, it tends to confuse the point that, for Plato himself, weight as determined by number is a necessary—if implicit—premiss of the later theory. Secondly, Aristotle's critique of Plato's account of direction in the second chapter of the fourth book of the *De caelo*, immediately prior to his statement and criticism of Plato's theory of weight as determined by number, seemed to me to make it implausible to claim that Aristotle had simply paid no attention at all to the later theory, and less implausible perhaps,

⁵ For this distinction between the common and the particular *pathemata*, see above pp. 108-9. Theophrastus includes among the *pathemata* the four kinds of χυμοί listed among the *gene* (59E5-60B5), following Plato's own backward reference at 65C1-2.

⁶ See above pp. 218-20.

⁷ Pp. 85-6 and 176-7 above.

⁸ Ch. VIII § 3, pp. 153-7 above.

⁹ Ch. IX-X, pp. 175-215 above.

but still unlikely, to suppose that Aristotle's remarks on direction were intended as in themselves sufficient refutation of Plato's whole account of weight as defined by resistance.¹⁰

I therefore preferred to pursue the formulation whereby Aristotle intends his criticism to cover both Plato's definitions, but deliberately discounts the features peculiar to the later definition, leaving in the later definition therefore only the premiss which it shares with the earlier theory, of weight as defined by number.

Admittedly, the distinction is a fine one. In practice, it makes little difference, so far as Aristotle's criticism is concerned, whether we argue that Aristotle disregards the later theory altogether, after his initial excursus on the question of direction, or whether we say that Aristotle deliberately discounts the features peculiar to the later theory, and therefore considers only the premiss which Plato's account of weight in terms of resistance has in common with the earlier theory, where weight is defined by number. I have made the distinction explicit here, only because it is essential to our appraisal of Theophrastus' critique of Plato.

For in his brief *résumé* of Plato's theory (cap. 83) Theophrastus does not allude, as Aristotle clearly does, to the definition of weight in terms of number. As I have noted, Theophrastus states Plato's theory in its later form, where weight is defined by resistance: 'what is light is easy to drag into a region other than its own, what is heavy is more difficult to move.' Moreover, it is this theory that Theophrastus plainly alludes to in the second sentence of his criticism (cap. 88). Plato's definition is restricted to substances of an earthy nature: 'for it is in these cases that what is heavy does appear to be difficult to move into a region that is not its own, while what is light is easier to move.' At the same time, I have argued, Theophrastus repeats precisely Aristotle's criticism: that Plato has failed to distinguish elements with different forms of absolute weight, and that his definition applies only to a single kind of substance, where the larger quantity is invariably the heavier, which in Aristotle's own system is true only of earth, or of substances that are made of earth.

It is important therefore to appreciate that Aristotle's criticism can apply equally to both Plato's definitions, to the definition of weight by number, and also to the definition of weight in terms of resistance, once we appreciate the various reasons—the nature of the *sensibilia*, the analysis of direction, the failure of the later theory to compare different

¹⁰ This last is Moraux's point, *De caelo* Budé edn cxlviii: 'Voulant détruire les propositions du *Timée* sur la pesanteur, Aristote s'est contenté d'en saper les fondations sans s'attarder à en démanteler les superstructures.' Cf. p. 182 n. 13 above. For the criticism of direction, see ch. IX § 3, pp. 185-91 above.

elements—that conspire to reduce the later theory, in Aristotle’s eyes, to a simple equivalence, for either element, of weight with size or number.

I am therefore myself inclined to take Theophrastus’ conjunction of these two ideas—the substance of Aristotle’s criticism joined to Plato’s *later* definition—as an indication that Aristotle did himself intend his criticism to cover the later no less than the earlier theory.

Even if that were not so, Theophrastus’ repetition, in the context of his opening criticism, of Plato’s later definition, is at least useful confirmation that Plato’s later definition, no less than the definition of weight in terms of number, is vulnerable, when viewed from the principles of Aristotle’s philosophy, to the charge that since the larger element is invariably the ‘heavier’, then on Plato’s theory there cannot be a distinction between two kinds of element.

(iii)

I conclude that, in the opening sentences of his criticism of Plato, Theophrastus repeats the essentials of Aristotle’s criticism: instead of distinguishing fire and earth as respectively light absolutely and heavy absolutely, Plato’s analysis applies to fire the rule which is in truth applicable only to earth.

What, for us, is new and significant in Theophrastus’ sentences is that Theophrastus attaches Aristotle’s criticism specifically to Plato’s definition of weight in terms of resistance.

Aristotle had appeared to ignore this version of Plato’s theory, and—with the exception of his remarks on ‘up’ and ‘down’—to direct his criticism exclusively to the earlier passage of the *Timaeus*, where weight is defined in terms of number.

The conjunction of ideas in Theophrastus is a good indication that Aristotle’s criticism is in fact intended to cover both forms of Plato’s definition, and that the features peculiar to Plato’s later analysis have been deliberately discounted by Aristotle (for the reasons, or the kind of reasons, that I suggested in my study of Aristotle’s criticisms), and that they have not been simply disregarded.

§ 3. FIRE AND AIR

Theophrastus’ criticism continues, *De sens.* 88 (*Dox.* 526.7-10): τὸ δὲ πῦρ καὶ ὁ ἀήρ ταῖς εἰς τοὺς οἰκείους τόπους φοραῖς κοῦφα καὶ ἔστι καὶ δοκεῖ. διόπερ οὐκ ἔσται τὸ μὲν πλεῖον τῶν ὁμογενῶν ἔχον βαρὺ, τὸ δὲ ἔλαττον κοῦφον (πλεῖον ... ἔλαττον Philippson, ἔλαττον ... πλεῖον codd.) · τὸ μὲν γὰρ πῦρ ὅσω ἂν ᾖ πλεῖον (Philippson, ὅσον ... πλησίον codd.), κουφότερον.¹¹

¹¹ Ludwig Philippson, "Ἰλη ἀνθρωπίνη (Berolini, 1831) 158-9, cf. 229. For my own emendation of this passage, see below pp. 238-9.

These concluding sentences of Theophrastus' first passage of criticism confirm the Aristotelean character of Theophrastus' approach. They are taken by Taylor as further confirmation of his thesis. I shall first give my own interpretation, and in the final section of the chapter I shall examine Taylor's reading of the passage.

(i)

Aristotle and Theophrastus agree with Plato, that the larger quantity of earth is heavier, and that the smaller quantity is less so. It is the behaviour of fire that establishes the difference between Aristotle's theory and that of Plato.

1. For Aristotle, the larger quantity of fire is lighter, and the smaller quantity is less so.
2. For Plato—as seen by Aristotle—there is no difference between fire and earth, in that the larger quantity of either element is the heavier, and the smaller quantity is lighter.

Thus in his opening criticism of Plato in the fourth book of the *De caelo*, it is the behaviour of fire that Aristotle introduces as a refutation of Plato's theory.

Aristotle first remarks that in allowing weight to be determined by the number of triangles, Plato has not been able to account for the difference between two forms of absolute weight, whereby earth and fire are respectively heavy absolutely and light absolutely, and whereby they travel in different directions therefore, fire to the circumference and earth to the centre (iv 2, 308b12-15).¹²

Aristotle then turns to the nature of fire. In so far as the triangles constitute a single kind of element, it would be possible, theoretically, for them to be characterised either as heavy absolutely or as light absolutely. And in the case of the Atomists, Aristotle does in fact allow either possibility: if the atoms all moved upwards, there would be nothing that could be heavy absolutely; if they all moved downwards, there would be nothing that could be light absolutely.¹³

When considering Plato's theory, Aristotle allows only the latter possibility: a body constituted from a larger number of triangles will be

¹² I have already remarked on the difference between fact and description in Aristotle's criticism (ch. X § 2, pp. 199-210; see also the first section of this chapter, pp. 227-8 above): earth and fire do move respectively to centre and circumference on Plato's theory; but, from Aristotle's point of view, they are, so to speak, not entitled to do so, since the triangles which make up earth and fire are not differentiated as heavy and light.

¹³ For this moment in Aristotle's criticism of the atomic theory, *De caelo* i 7, 275b29-276a6, see vol. i pp. 11-14.

heavier; there cannot therefore be anything which is light absolutely, and which would be lighter therefore in the larger quantity.

Thus in the continuation of his opening criticism, Aristotle argues that fire, for Plato, cannot travel upwards (i.e. towards the circumference) by nature, as the result of its allegedly having a smaller number of triangles. For a larger quantity of fire will have more triangles, and on the definition which Aristotle has attributed to Plato it will therefore be heavier. In that case, the larger quantity should on Plato's theory be *less* inclined to travel upwards (308b15-18).

But in fact just the opposite is the case. Since fire is light by nature, the more fire there is, the lighter it is, and the more quickly therefore it travels upwards; while equally the smaller quantity will travel downwards (i.e. away from the circumference) more quickly, and the larger quantity will travel downwards more slowly (308b18-21).¹⁴

Aristotle then applies this same argument to air (308b21-8). On Plato's theory air, in a certain quantity, would be heavier than water, in a certain quantity; and air should therefore move downwards in water. But in fact the opposite is the case: any quantity at all of air moves upwards, in water, and the larger quantity moves upwards more quickly.¹⁵

(ii)

These two arguments are utilised by Theophrastus in the sentences quoted at the head of this section (*Dox.* 526.7-10).

In his opening sentence of criticism (*Dox.* 526.5-6), Theophrastus repeats the point that Plato has failed to distinguish elements with opposite forms of absolute weight.

¹⁴ Again I have already commented on the anomaly whereby Aristotle takes Plato's description of the larger quantity of fire as 'heavier', but gives this term the meaning which it would have in his own philosophy. If the larger quantity of fire were really heavier—so Aristotle argues in effect—it would have to move more slowly towards the circumference and more quickly away from it, which both Plato and Aristotle agree is not the case: hence the paradox whereby Aristotle offers in *refutation* of Plato precisely the feature in the behaviour of fire which both philosophers would in fact agree upon. For this analysis, see pp. 199-210 above.

¹⁵ The principle of Aristotle's criticism is essentially the same for air as for fire. Aristotle in fact believes that, measured in fire, air is heavy, and heavier in the larger quantity; but measured in earth or water, air is light, and lighter in the larger quantity (cf. *De caelo* iv 4, 311a22ff.). This latter description is contrary to the implication of Plato's theory, where the body with a larger number of triangles is heavier, and where therefore a large quantity of air must be heavier than a small quantity of water. Plato would presumably not wish to deny that in water air will move towards its parent body, nor even that it would do so more quickly in the larger quantity; these 'facts' are presented as a refutation of his theory, because 'heavier' is given the meaning (requiring movement 'downwards', and therefore centripetal movement) which it would have in Aristotle's own philosophy. For this criticism, see pp. 211-12 above.

He then repeats (*Dox.* 526.6-7) Aristotle's general point, that Plato's elements are all of the same kind, in that the larger quantity is invariably the heavier, which in Aristotle's system is true only of earth. This, I have argued, is the point of Theophrastus' saying that Plato 'has defined heavy and light for earthy substances' only.

Theophrastus now (*Dox.* 526.7-10) repeats the point that the behaviour of fire or of air gives the lie to Plato's theory. For fire and air, he tells us, both are, and are seen to be, light in virtue of their movement towards their natural places, i.e. in virtue of their movement upwards. The larger quantity of fire is therefore lighter than the smaller quantity, contrary to the terms of Plato's definition, where the larger quantity of any element is invariably heavier.¹⁶

(iii)

In writing thus, I have taken the unusual—and superficially unorthodox—approach of determining what it is that Theophrastus must say, before attempting to establish precisely the words by which he says it.

For initially the point to appreciate is that whichever reading we adopt of the sentences I have quoted the meaning will ultimately be the same.

1. According to the manuscripts, Theophrastus says that it will not be the case that the *smaller* quantity is *heavy*, while the *larger* quantity will be *light*.

2. If we adopt Philippon's emendation, Theophrastus says that it will not be the case that the *larger* quantity is *heavy*, while the *smaller* quantity will be *light*.

According to the *first* reading, the point will have to be that *on Plato's theory* it is not the case, as it is *in fact*, that for fire or for air the smaller quantity is heavier, and the larger quantity light.

According to the *second* reading, the point will have to be that it is not the case *in fact*, as it must be *on Plato's theory*, that for fire or for air the larger quantity is heavy and the smaller quantity light.

¹⁶ When Theophrastus writes that air and fire 'both are and are seen to be light in virtue of their movement to their natural places' (*Dox.* 526.7-9), there will be, as in the equivalent passage of Aristotle, the implicit restriction that this is true only for the movement of air in the region of earth or water, i.e. for the natural movement of air 'upwards'. Air, in relation to fire, moves downwards and is heavy. No equivalent restriction is needed for fire, since in moving towards its natural place fire can move only 'upwards'. Theophrastus therefore simplifies his final criticism (*Dox.* 526.9-10) by including only the calculation of fire. For the equivalent passage in Aristotle's criticism of Plato (*De caelo* iv 2, 308b21-8), see above pp. 211-12. For air and fire in Aristotle's own theory, see *De caelo* iv 4, 311a15ff., esp. 311a22-9 and b4-9. For Taylor's misunderstanding of the distinction in Aristotle's philosophy between the (absolute) lightness of fire and the (relative) lightness of air, see p. 242 n. 22 below.

For Theophrastus cannot mean to deny that in fact the larger body is light: for on Aristotle's theory this is true of fire. On the manuscript reading therefore he can intend to deny only that what is in fact the case can be true for Plato.

(iv)

The choice therefore between the manuscript reading and Philippon's emendation lies not in any question of substance or of logic, but in the sequence of thought. Which version answers better to the argument which has preceded, and to the sentences which follow?

If we take the manuscript reading, then the connection of thought must be primarily with the first sentence of Theophrastus' criticism, and only secondarily with the intervening sentence on the behaviour of fire and air. The sequence of thought will be that Plato's definition of heavy and light is true only for 'substances of an earthy nature' and that therefore it cannot be true for Plato (διόπερ οὐκ ἔσται ...) that the smaller quantity is heavy and the larger quantity light, as is in fact seen to be the case for fire and air.

If we adopt Philippon's emendation, then the sequence of thought has to be the other way round. The sentence διόπερ οὐκ ἔσται follows directly from the example of fire and air, and relates only indirectly to the restriction of Plato's definition to 'earthy substances'. The sequence of thought will be that for fire and air it is not the case (διόπερ οὐκ ἔσται ...) that the larger quantity is heavy and the smaller quantity light; this is true only for substances of an earthy nature.

Which reading of the passage is more natural?

The sentence follows on from, and is in turn followed by, Theophrastus' statement of his own belief, that fire and air are light, and the *assertion* that a larger quantity of fire is *lighter* than a smaller quantity.

This latter formulation makes it more natural, it seems to me, for Theophrastus to *deny* therefore that *in fact* the larger body is always, or necessarily, *heavier*.

It seems to me therefore that the sequence of thought favours the sense given by Philippon's emendation:

'It will not be true <in fact, as it is on Plato's theory,> that the larger quantity is heavy, and that the smaller quantity is light.'

(v)

The essential point however is to appreciate that the reading of the manuscripts cannot represent Theophrastus' own belief.

If Theophrastus denies that a body with 'the *smaller* quantity of like constituents' is *heavy*, and that a body with a *larger* quantity is *light*, he

must mean to deny that this is so for Plato. He cannot deny that this is so in fact.

If therefore we prefer to make Theophrastus' denial a denial of what in fact is so, then we must make the sentence a denial that what is *larger* is necessarily *heavier*, and that what is *smaller* is *lighter*.

The manuscript reading cannot be a denial of what, for Theophrastus, is so *in fact*.¹⁷

(vi)

One final refinement.

The sequence of thought, or so I have decided, leads more naturally to taking the sentence as a denial of what, for Theophrastus, is so *in fact*: 'therefore it is not the case <in fact, as it has to be for Plato> ...'.

There are however two ways by which we can arrive at this meaning: by interchanging ἔλαττον and πλεῖον, or by interchanging κοῦφον and βαρύ.

Philippson adopts the former solution. But the latter alteration seems to me to give more point to (and to receive more point from) the sentence which follows.

1. Theophrastus first tells us (*Dox.* 526.9-10) that it is not true in fact, as it has to be for Plato, that the larger quantity of fire is *heavy*.
2. He then reminds us (*Dox.* 526.10) that in fact the larger quantity of fire is *lighter*.

The final two sentences of my quotation (*Dox.* 526.9-10) I would therefore read as: διόπερ οὐκ ἔσται τὸ μὲν ἔλαττον τῶν ὁμογενῶν ἔχον κοῦφον, τὸ δὲ πλεῖον βαρύ (βαρὺ ... κοῦφον codd.)· τὸ μὲν γὰρ πῦρ ὅσω ἂν ᾖ πλεῖον, κορυφότερον.

I translate:

¹⁷ It could be claimed that the manuscript reading does provide a denial of what, for Theophrastus, is so in fact, if we take account of the refinement in Aristotle's theory whereby no quantity of fire is heavy, and no quantity of earth is light (*De caelo* iv 4, 311a15ff.). The denial that the small quantity is heavy and the large quantity light would then be a denial of what, for Theophrastus, is so in fact: since for Theophrastus the large quantity of fire will be light, but the small quantity would be only 'less light', it would not be in any positive sense 'heavy'. I shall take up this point in the section immediately following, in answer to Taylor's criticism. For the moment, it is enough to note that Theophrastus fairly clearly does not mean to exploit this distinction in Aristotle's theory, since in his opening sentences of criticism (*Dox.* 526.5-7) he does in fact write of 'heavy' and 'light' in relation to 'earthy substances', thus ignoring the point that, on Aristotle's theory, earth is not in any positive sense 'light'.

'It will not therefore be the case <in fact, as it has to be for Plato> that the body with the *smaller* number of like parts is *light* and that the body with the *larger* <number of like parts> is *heavy*.

'For fire, however much the *more* of it there may be, is *lighter*.'

§ 4. TAYLOR'S ERROR

(i)

Taylor retains the manuscript reading:

'It might seem tempting at first to exchange the places of *πλεῖον* and *ἐλαττον* as Philippson does, but the existing text really gives a better sense.'

Taylor then quotes part of the passage from Aristotle which I paraphrased earlier in this chapter (iv 2, 308b15-21), and writes:

'Theophrastus means that according to Plato's account of the matter it would be possible in some cases for a smaller bulk to be heavier than a larger bulk of the same composition, and ... for a larger bulk to be lighter than a smaller bulk of the same composition.'¹⁸

I have already argued that this cannot in fact be Plato's meaning. What is important to note here is the completely erroneous way in which Taylor imagines that his interpretation is somehow supported by, or at least paralleled in, Aristotle's criticism of Plato.

Aristotle does write, as Theophrastus also does, that the more fire there is the lighter it will be. But in Aristotle, as in Theophrastus, this fact is not offered as an interpretation of Plato. Quite the contrary. It is offered as a *refutation* of Plato's theory, as a fact which Plato either did not know of or ignored, and which, once appreciated, will *controvert* his theory.

For Aristotle has stated that on Plato's theory each body will be heavier if it contains a larger number of triangles. It is Aristotle's *own* belief that fire is lighter the more there is of it: and this fact therefore is offered as a *refutation* of Plato's belief.

(ii)

As it is, the passage in Aristotle effectively refutes Taylor's belief that while for Plato a large quantity of fire is heavier when measured at the circumference, nonetheless it is lighter when measured at the centre, and that conversely a larger quantity of earth is heavier when measured at the centre, but would be lighter if measured at the circumference.

For Aristotle makes no qualification that the conjunction of larger and heavier in Plato's theory is true only of fire which is measured at the circumference, or of earth which is measured at the centre.

¹⁸ Stratton, 215-16. For the passage from Aristotle, see pp. 199-200 and 234-5 above.

On the contrary, not only does Aristotle say that the correlation of weight and size is true, on Plato's theory, for '*every* body of like kind' (308b8): in the passage that I have paraphrased (308b18-21), Aristotle offers *both* the movement of fire away from the centre and towards the circumference *and* the movement of fire away from the circumference and towards the centre as indication that the more fire there is the lighter it will be.

It is virtually impossible therefore for Aristotle to believe that Plato's theory of fire, whether moving towards or away from its 'natural' place, or its 'parent element', can have entailed the belief that the larger quantity of fire will have been the lighter.

For this is precisely the fact that Aristotle offers as sufficient *refutation* of what he has stated to be Plato's belief, namely that *every* body is heavier if it has a larger number of equal parts.

(iii)

Now it is true that I have argued, in my analysis of Aristotle's criticism of Plato, that Aristotle offers as a refutation of Plato a fact that Plato himself would have been happy to agree to. For Plato, as for Aristotle, the larger quantity of fire will be more difficult to move away from the circumference, or will move away from the circumference more slowly. But for Plato the larger quantity of fire is therefore accounted as heavier, while for Aristotle it is lighter. The point of Aristotle's criticism is that if the larger quantity of fire is heavier, as Plato claims it is, and as it must be, Aristotle supposes, if all things are made from different quantities of a single material principle, the triangles, then it should be less difficult, and not more difficult, to move away from the circumference, and towards the centre, or at least that the larger quantity would move away from the circumference more quickly; and so Aristotle is able to offer the sluggish movement of a larger quantity of fire away from the circumference as a refutation of Plato's theory.

What Taylor's interpretation would require is that on Plato's theory the larger quantity of fire should move away from the centre more quickly, as it will do in Aristotle's theory, and that in doing so it should be recognised by Plato as lighter.

But if this were the case, Plato's theory, on this point, would be identical to that of Aristotle both in fact and in expression, and there would be no occasion for Aristotle to claim, as he does, that the larger quantity of fire, in moving away from the centre, is on Plato's theory the heavier.

As it is, Theophrastus' claim that fire and air, in moving towards their own places, 'both are and are seen to be light', and his claim that fire is

lighter in the larger quantity, are intended to act as a refutation of Plato's theory, since on that theory the larger quantity of fire is *heavier*, both according to Plato's own formulation, and equally as a consequence of the material monism that Aristotle and Theophrastus attribute to Plato.

(iv)

Taylor continues:

'This'—the disproportion, in Plato's theory, between weight and size—'is in fact probably true. ... Aristotle and Theophrastus maintain, as against this, that light does not mean "not so heavy" as something else, but that heavy and light are positive contraries like black and white. (This point is expressly stressed in the chapter of the *de Caelo*.)'¹⁹

Taylor is in difficulties.

According to the manuscript reading, which Taylor adopts, Theophrastus denies that a substance composed from a small quantity of like parts is heavy.

Taylor believes that on Plato's theory a small quantity of like constituents is in fact heavy, in the case of a small quantity of fire measured at the centre, or a small quantity of earth measured at the circumference.

But for Aristotle, and so for Theophrastus, it is equally true that a small quantity of fire is heavier than—or at least not so light as—a large quantity.

Theophrastus' denial must therefore be intended as a denial *both* of what for Plato is so *and* of what is in fact the case.

How can this be so? What then is the point of his criticism?

In the sentences that I have quoted, Taylor attempts to distinguish Plato's view from that of Aristotle on the ground that Plato can speak of fire and earth as alike being 'heavy' or 'light', whereas for Aristotle, and for Theophrastus, earth can be only 'heavy' or 'not so heavy', while fire conversely can be only 'light' or 'not so light': a 'point', Taylor tells us, which 'is expressly stressed in the chapter of the *de Caelo*', where Aristotle first criticises Plato (iv 2, 308a34ff.).

Now I do believe that the distinction which Taylor draws here is in fact a feature of Aristotle's theory. But it is not expressly stated until later in the *De caelo*.²⁰ In the second chapter of book four, Aristotle states only the general principle of the distinction between absolute and relative weight, from which the more particular point might perhaps be inferred. Even so, the point which Aristotle will make later cannot be intended by Theophrastus in the present passage.

¹⁹ Stratton, 216.

²⁰ *De caelo* iv 4, 311a15ff. I explore this point in my third essay.

Aristotle's point relates only to the two extreme elements, earth and fire, which are respectively heavy and light in an absolute sense. Since fire has absolute lightness, it will be true that the smaller quantity of fire, in being less light, will not therefore be in any positive sense heavy or heavier; the smaller quantity of earth, in being less heavy, will not be in any positive sense light or lighter.

But this distinction does not attach to the description of the two intermediate elements, water and air. Aristotle tells us explicitly that these two elements are both lighter than earth and heavier than fire. This difference between the extreme elements (fire and earth) and the intermediate elements (air and water) is essential to Aristotle's whole conception of the distinction between absolute and relative weight.²¹

The point which Taylor picks out from Aristotle's theory applies therefore only to fire or earth, and not to air or water. Since, at this place in the *De sensibus*, Theophrastus' criticism is explicitly related both to fire and to air (*Dox.* 526.7-8), this therefore cannot be the feature in Aristotle's theory which Theophrastus means to exploit in his criticism of Plato—unless we are to suppose that Theophrastus has completely misunderstood Aristotle's theory, which would be a wild and wholly unnecessary assumption.

Not only does Taylor's version of the criticism contradict Aristotle's theory; even in Theophrastus, this distinction is given *the opposite way round* to the way in which it would have to be presented if Taylor's interpretation were true. 'It will not be the case', so Taylor's interpretation tells us, 'that a small quantity of like elements, in the case of fire, can be heavy, while only the larger quantity is lighter.' The argument, on Taylor's interpretation, should then continue: 'For in the case of fire the small quantity cannot be heavy, it too must be light, though "not so light" as the larger quantity.'

But this is not what we find in the text. The point which Theophrastus chooses to repeat is that the *larger* quantity of fire is light (*Dox.* 526.10). But this is the point which, on Taylor's interpretation, would be *true* in Plato's theory, as seen by Aristotle and by Theophrastus. On Taylor's interpretation, the point which needs correction is not that the larger quantity of fire is light or lighter, but that the smaller quantity must also be described as 'light' or as 'not so light'. And of that correction there is no trace in the text.²²

²¹ Cf. *De caelo* iv 4, 311a22-9. The fact that, in this passage, Aristotle writes of air and water as 'heavy and light absolutely in relation to each other' does not undercut the distinction that I have stated between the absolute weight of the extreme elements and the relative weight of the two intermediate elements. The purpose of Aristotle's refinement here I shall seek to explain in my later essays.

²² Part of the reason for Taylor's misunderstanding this text is that he misunderstands

(v)

I conclude therefore that for Aristotle, as for Theophrastus, the refutation of Plato's thesis lies in the explanation that is given of the behaviour of fire.

Aristotle will grant that a larger quantity of earth is heavier, and that a small quantity is less so. The fault with Plato is that he tries to apply this rule to fire as well as to earth. But fire, according to Aristotle, is lighter in a larger quantity.

Theophrastus repeats this criticism. If we adopt the emendation of the manuscripts suggested in the preceding section, then the point will be that:

'It will not be the case <in fact, as it must be on Plato's theory,> that the smaller quantity is light, and the larger quantity heavy, for <in fact> the more fire there is, the lighter <it will be>.'

The meaning must be the same with the manuscript reading, where 'heavy' and 'light' are the other way round:

'It will not be the case <for Plato, as it is in fact,> that the smaller quantity is heavy, and the larger quantity light, for <in fact> the more fire there is, the lighter <it will be>.'

Either interpretation is precluded by Taylor's assumption that for Plato a larger quantity of earth will be heavier at the centre, but lighter if measured at the circumference, while conversely a large quantity of fire will be heavier at the circumference, but lighter if it is measured at the centre. For on this assumption Plato's theory does contain—as Aristotle and Theophrastus demand that it should—the rule that a larger quantity of fire will be lighter than a smaller quantity. For on Taylor's interpretation of Plato's theory, this will be *true*, at least for fire which is measured at the centre.

Aristotle's theory of absolute weight. For Taylor believes that: 'Aristotle and Theophrastus hold that ... *no* air or fire <is> heavy' (Stratton, 217). This is because Taylor has read the remarks about fire and air in Aristotle (*De caelo* iv 2, 308b27) and in Theophrastus (*Dox.* 526.7-9) without taking account of the refinements in Aristotle's own theory (cf. p. 212 n. 23 and p. 236 n. 16 above). On Taylor's reading, both air and fire would manifest absolute lightness. But in fact Aristotle tells us that, in relation to fire, air will be heavy, and presumably therefore heavier in the larger quantity: see esp. *De caelo* iv 4, 311a22-9 and b4-9. Fire alone is light absolutely (e.g. 311b4-5). Theophrastus and Aristotle have, naturally enough, deployed against Plato only that part of Aristotle's theory which is inconsistent with Plato's belief, and therefore adduce only the point that, in its upward movement, air, like fire, is lighter in the larger quantity. The point that, measured in fire, air would be heavy, and heavier therefore in the larger quantity, has no polemical value, and is therefore left for Aristotle's own exposition of his theory, after his criticism of Plato and the Atomists (*De caelo* iv 3, 310a16ff.). For the complementary error in Taylor, his attributing 'absolute' heaviness to earth and to water, see p. 275 n. 8 below.

At this point therefore Taylor's dilemma is at its most acute. For on Taylor's interpretation, *both Plato and Aristotle* believe that when fire is measured at the centre the larger quantity is lighter, and the smaller quantity is heavier, or 'not so light'. Taylor is embarrassed therefore to know how to interpret the present sentence: for since the present sentence (in the reading of the manuscripts) *denies* this equivalence it cannot easily be taken either as a statement of Aristotle's own theory or as a refutation of Plato.

By introducing the distinction between 'heavy or light' and 'heavy or not so heavy', Taylor seeks in fact to interpret the sentence as a refutation of Plato's theory. But the truth is that even for Theophrastus' most scrupulous reader the distinction is scarcely able to bear the weight imposed upon it.

In this dilemma, the point to appreciate is that the part-coincidence between Theophrastus', and Aristotle's, theory and Taylor's interpretation of Plato is not accidental. As I noted earlier, the presumption must be that Taylor's interpretation is in fact the product in part of Taylor's unconscious introduction of Aristotelean elements into the text of Plato. For Plato himself states only that a larger quantity of fire, measured at the *circumference*, will be *heavier*. Taylor merely assumes, in part perhaps from what I have called the alignment of opposites, and in part presumably as the result of his knowledge of Aristotle, that a larger quantity of fire, measured at the *centre*, will be *lighter*.

I have already argued that this cannot be Plato's meaning. What is significant here is that the two theories, that of Plato and that of Aristotle, are too close, on Taylor's interpretation, for the radical criticism which I have argued that Theophrastus makes of Plato's theory to be inserted between them.

Paradoxically, it is precisely the Aristotelean element which Taylor has introduced into Plato's text which makes it impossible for him to explain Aristotle's, or Theophrastus', criticism of Plato. Taylor's interpretation of Plato, in being unconsciously derived from Aristotle, leaves Theophrastus no room from which to criticise Plato's theory, without inflicting fatal damage on the theory which Theophrastus himself holds to be true.²³

²³ Cf. vol. i pp. xv-xvi.

CHAPTER THIRTEEN

THEOPHRASTUS: THE TWO 'LOGOI'

§ 1. THE PROBLEM

I turn therefore to the second part of Theophrastus' criticism.

In the earlier part of his analysis, Theophrastus has repeated essentially Aristotle's criticism of Plato, particularly in the form in which it is expressed in the second chapter of the fourth book of the *De caelo*. Plato has not distinguished elements with different forms of absolute weight. His definition of heavy and light applies in fact only to the case of earthy bodies. Fire and air controvert the theory that the body composed of a larger number of like elements is necessarily the heavier.

This repetition of Aristotle's criticism has afforded no handle for Taylor's interpretation of Plato. On the contrary, the criticism in Aristotle and in Theophrastus excludes Taylor's interpretation. For on Taylor's interpretation Plato believes that the larger quantity of fire is lighter when measured at the centre, whereas both Aristotle and Theophrastus offer the point that the larger quantity of fire is lighter as a *refutation* of Plato's theory.

In the second half of his criticism Theophrastus seeks to go beyond Aristotle. His purpose here is to exploit the case against Plato, so as to show that not only will Plato's formula not apply to the behaviour of fire, but that it is inconsistent even as an account of earthy substances, in that on Plato's theory, Theophrastus argues, different quantities of earth would not have the same weight, relatively to one another, when moving towards their natural, or native, place and away from it.

This yields a situation which is similar to Taylor's interpretation of Plato's original theory. But the resemblance is only superficial. The coincidence between Taylor's interpretation and Theophrastus' criticism arises, I shall argue, only because Theophrastus has himself sought to interpret the Platonic definition of weight in terms of Aristotle's account of weight as expressed by differences of speed, and in a way that is designed to show up Plato's theory as inconsistent.

Seen in this way, Theophrastus' criticism, far from supporting Taylor's interpretation of the *Timaeus*, still tells against it. For Taylor interprets as an expression of Plato's theory conclusions which Theophrastus has himself produced, from a conflation of Platonic and Aristotelean ideas, and which are again intended as a refutation of Plato's theory.

For the moment, however, in this chapter, I shall take only the first part of Theophrastus' criticism (*Dox.* 526.10-14), where the ground is prepared for the charge of inconsistency, but where the charge of inconsistency is not yet made.

For this part of Theophrastus' text contains a serious difficulty, which has never yet been resolved: the problem of the two *logoi*. The resolution of this difficulty is essential to a clear understanding of the nature of Theophrastus' criticism as a whole.

(i)

At the beginning of the second part of his criticism, Theophrastus writes, *De sens.* 88 (*Dox.* 526.10-13): ἀλλ' ἄνω μὲν τιθεμένου τοῦ πυρὸς ἐφαρμόσουσιν οἱ λόγοι καὶ οὗτος κάκεινος, ἐνταῦθα δ' οὐδέτερος. ὡσαύτως δὲ καὶ ἐπὶ τῆς γῆς· ἄνωθεν γὰρ δεῦρο θᾶττον οἰσθήσεται τὸ πλεόν.

In the opening sentence of this passage, Theophrastus tells us, at first sight rather enigmatically, that:

'When fire is placed aloft, both formulae'—*logoi*—'will apply, but here neither of them will.'

The contrast is evidently between the behaviour of fire at the circumference, and its behaviour 'here', on earth.

Theophrastus continues:

'The same is true of earth: for the larger quantity' of earth 'will be carried from above to here', i.e. to the centre, 'more quickly.'

What are the two *logoi*? How are they intended to relate to the behaviour of fire and earth at the circumference and 'here', i.e. at the centre?

(ii)

I start by taking a look at earlier interpretations of the two *logoi*.

1. For Diels, the two formulae are 'the larger' and 'the smaller', namely that the larger of two bodies is the lighter, and that the smaller is the heavier (retaining the manuscript reading at *Dox.* 526.9-10).¹

2. For Taylor, the two formulae are those of the heavy and the light, namely that the heavier body is the more difficult to move into an alien region, while the lighter body can be moved more easily.²

¹ Hermann Diels, *Doxographi graeci* (Berolini, 1879) 526 apparatus. I hope that Diels' laconic note is meant to have the meaning which I have given it.

² Stratton, 216-17; cf. *Commentary* 443-4.

3. Stratton in effect amalgamates both interpretations. He proposes that Taylor's two formulae should be accounted as a single *logos*, and that the second *logos* is that of 'the larger' and 'the smaller', as proposed by Diels, but with the difference that Stratton adopts Philippson's emendation, so that this *logos* comes out in the form that the larger quantity is heavy and that the smaller quantity is light.³

None of these interpretations will bear scrutiny, if we seek to work out the implication for Theophrastus, in the passage I have quoted, of the point that the two *logoi* will be true, or will 'apply', to the behaviour of fire at the circumference, but not to the behaviour of fire 'here', i.e. when measured at the centre.

(iii)

Thus Diels' formula, applied to the text of Theophrastus, will presumably mean that:

1. At the circumference, the larger quantity of fire is lighter, and the smaller quantity is heavier.
2. But here on earth neither formula is true.

But although the *first* point Aristotle and Theophrastus would agree is true, they would not be able to agree that tested at the centre the same formula is *not* true, as is required by the *second* point. For according to Aristotle and Theophrastus it *will* be true that the larger quantity of fire is lighter, and the smaller quantity heavier, or more strictly 'less light', at the centre *no less than* at the circumference. This is precisely what is meant, or part of what is meant, by fire being light 'absolutely'.

Taylor's interpretation runs into just the opposite difficulty. Taylor's two formulae are presumably intended to mean that the larger quantity of fire is more difficult to move at the circumference, and that the smaller quantity is more difficult to move at the centre. The larger quantity of

³ *Greek physiological psychology* 219. So far as I can see, McDiarmid's interpretation is in practice the same as Stratton's, only arrived at by a different route and with no acknowledgment made of Stratton: see *Phronesis* 4 (1959) 68-9, and cf. p. 218 n. 5 above.

Taylor is incorrigibly careless. He purports to compare Stratton's interpretation with his own, *Commentary* 443-4, but he nonetheless completely misrepresents the text which Stratton's interpretation is based on. Thus at *Dox.* 526.9-10, Stratton and Philippson do not transpose 'heavy' and 'light', as Taylor tells us that they do in his *Commentary* 443. They transpose 'larger' and 'smaller' (Stratton, 146-7 and 218-19; for Philippson's emendation, see p. 233 above), which Taylor had recognised as Philippson's emendation in the notes which he had sent to Stratton ten years before the publication of his *Commentary* (see Stratton 215). Admittedly, the sense of either emendation is ultimately much the same (cf. pp. 238-9 above); but how can Taylor claim to have considered seriously Stratton's interpretation, when he is capable of making such an elementary error of fact?

fire is therefore heavier at the circumference, and the smaller quantity is heavier at the centre. But for Theophrastus and for Aristotle it cannot then be true that this formula will be true, or will 'apply', at the circumference, and not at the centre. Exactly the opposite will be the case. Theophrastus and Aristotle believe that the larger quantity of fire is lighter and that the smaller quantity is heavier, or at least 'less light'. For Theophrastus and for Aristotle, Taylor's formula would therefore be *true* at the centre, and *not true* at the circumference, contrary to Theophrastus' assertion that, for fire, the two *logoi* are *true*, or will 'apply' at the circumference, and *not* at the centre.

Stratton's interpretation runs into both difficulties, with the difference only that whereas the formula which Diels proposes (the larger quantity of fire is lighter) would be true at the centre *no less than* at the circumference, the formula that Stratton chooses (the larger quantity of fire is heavier) is *not* true, Theophrastus believes, *even* at the circumference.

None of these interpretations therefore is able to answer to Theophrastus' claim that the two *logoi* would be *true* for fire at the circumference, and *not true* at the centre.

What other formulations then can we find, in this context, for the identity of the two *logoi*?

§ 2. THE FIRST 'LOGOS'

(i)

In order to identify the two *logoi*, I suggest that we begin by taking account of Theophrastus' own beliefs on the various correlations of size with speed and with ease or difficulty of movement.⁴

Aristotle frequently asserts that a larger quantity of any element travels towards its natural place more quickly. Thus for earth and for fire:

1. A larger quantity of earth travels towards the centre more quickly; a smaller quantity travels more slowly.
2. A larger quantity of fire travels towards the circumference more quickly; a smaller quantity travels more slowly.⁵

⁴ Cf. pp. 202ff. and p. 228 n. 4 above. I assume in what follows that Theophrastus will share the essentials of Aristotle's own beliefs on the nature of weight and on the movement of the elements. The points to establish will be those where Theophrastus goes beyond Aristotle in entertaining certain correlations between Aristotle's beliefs and principles which are present in, or may be spun out of, the *Timaeus*.

⁵ E.g. *De caelo* iv 4, 311a21. This feature of Aristotle's theory is examined in detail in my third and fourth volumes.

Theophrastus endorses this belief when in the sentences I have quoted he writes that the larger quantity of earth travels 'from above to here', i.e. to the centre, more quickly (*Dox.* 526.12-13).

The converse association is true for movement by constraint. Thus in the criticism of Plato which I paraphrased in an earlier chapter, Aristotle wrote that 'the larger quantity of fire will be lighter, and will travel upwards more quickly, whereas when fire travels from above to below,' and when therefore it is moved by constraint, 'the small quantity will travel more quickly, and the large quantity will travel more slowly'.⁶

The same correlation we may assume will be true for earth. Thus for earth and for fire:

1. A larger quantity of earth travels away from the centre more slowly; a smaller quantity travels more quickly.
2. A larger quantity of fire travels away from the circumference more slowly; a smaller quantity travels more quickly.

In general, Aristotle speaks of speed in connection with weight, while Plato speaks of ease or difficulty of movement. But at one point, as I have noted already, Plato writes that the smaller portion of earth will be easier to drag into an alien region, and 'will arrive there the sooner' (*πρότερον*, 63D2).⁷

Now further, in his opening criticism of Plato, Theophrastus in effect endorses Plato's point that for substances of an earthy nature it is difficult to drag away what is heavy into a region other than its own, and easier to move what is light (*Dox.* 526.6-7). For Theophrastus, speed therefore is aligned with ease or difficulty of movement, at least for the measurement of earth at the centre, as in effect it is for Plato. The larger quantity of earth is more difficult to move away from the centre, and moves, or is moved, more slowly; the smaller quantity is easier to move, and moves, or is moved, more quickly.

I would suggest that we can apply the same rule to the measurement of fire at the circumference. The larger quantity of fire would be more difficult to move away from the circumference, and moves, or is moved more slowly. The smaller quantity would be easier to move away from the circumference, and moves, or is moved, more quickly.⁸

⁶ iv 2, 308b19-21: see pp. 199-200 and 205-6 above.

⁷ Cf. p. 203 above.

⁸ This transference, from what Theophrastus says of earth to what we may suppose he believed of fire, is possible only because I am so far treating exclusively of the alignment of size with speed and with difficulty or ease of movement. Theophrastus and Plato would of course disagree on the lesson to be drawn from this alignment for the designation of the larger and the smaller quantity as heavy or light: for Theophrastus, the larger quantity of

Altogether, therefore, I would suggest that, for Theophrastus, we may adopt the following associations.

Measured at the circumference

1. A large quantity of fire moves towards the circumference more quickly; but it moves, or is moved, away from the circumference more slowly, and with greater difficulty, than a smaller quantity.

2. A large quantity of earth moves away from the circumference more quickly; but it moves, or is moved, towards the circumference more slowly, and with greater difficulty, than a smaller quantity.

Measured at the centre

1. A large quantity of fire moves away from the centre more quickly; but it moves, or is moved, towards the centre more slowly, and with greater difficulty, than a smaller quantity.

2. A large quantity of earth moves towards the centre more quickly; but it moves, or is moved, away from the centre more slowly, and with greater difficulty, than a smaller quantity.⁹

(ii)

Armed with these conclusions, I turn therefore to the identification of 'the former *logos*'.

The first obvious formula which we find in Theophrastus' passage is that which correlates heavy and light with difficulty and ease of movement: 'a heavy body is difficult to move into a region other than its own, a light body is easier to move'. This is the correlation which Theophrastus advances as representing Plato's theory, and which he has repeated in his opening sentences of criticism (*Dox.* 526.5-7). This therefore provides an obvious candidate for 'the former *logos*'.

But if we do no more than repeat the Platonic correlation of ease or difficulty of movement with weight (as on Taylor's interpretation), then fire which is difficult to move away from the circumference will be *heavy*, and fire which is easier to move will be *light*.

But for Theophrastus as for Plato, or so I have suggested, the fire which is more difficult to move away from the circumference is the larger quantity, and for Theophrastus as for Aristotle the larger quantity of fire is *lighter*.

fire, which would be more difficult to move away from the circumference, and which moves, or is moved, more slowly, is therefore lighter, and not heavier, as Plato supposes it to be.

⁹ Note that in this table I have so far deliberately omitted to specify the movement of fire away from the centre and towards the circumference, and the movement of earth away from the circumference and towards the centre (i.e. what Aristotle and Theophrastus would call the 'natural' movement of either element), in terms of ease or difficulty of movement: for we have no *direct* knowledge of Theophrastus', or of Aristotle's, opinion on this point. See further pp. 251-2 below.

It is impossible therefore (as I have already noted in objecting to Taylor's interpretation) for Theophrastus to say of Plato's correlation, in this form, that it will be true, or will 'apply', when fire is measured at the circumference.

I suggest therefore that we replace weight with size. From the correlation which Theophrastus initially offers, of weight with ease or difficulty of movement, we exclude the specification of weight, and we extract only the implied correlation of ease or difficulty of movement with size:

'In the case of earthy bodies, the heavier' (and therefore, for Theophrastus as for Plato, the larger) 'body will be more difficult to move into a region other than its own, while the lighter' (and therefore, for Theophrastus as for Plato, the smaller) 'body will be easier to move' (cf. *Dox.* 526.6-7).¹⁰

The 'former *logos*' will therefore be simply that the larger quantity is more difficult to move into a region other than its own, while the smaller quantity will be easier to move.

This *logos* will then be true for fire at the circumference: the larger quantity is more difficult to move away from the circumference, the smaller quantity is easier to move.

(iii)

But how are we then to decide that this *logos* will *not* apply to the measurement of fire at the centre?

We face here the difficulty that I noted when commenting on Plato's own possible extension to his theory.¹¹ When fire moves away from the centre, it moves according to nature, on Aristotle's theory, and there is therefore no immediately obvious sense in which different quantities would be either easier or more difficult to move.

The solution to this problem, I would suggest, is simply that Theophrastus continues to associate ease or difficulty of movement with speed, for the movement of an element *towards* its natural place, no less than for the movement of an element *away from* its natural place.

1. According to Aristotle, the larger quantity of fire moves away from the circumference, and towards the centre, more slowly; Plato supposes that the larger quantity of fire is more difficult to move.
2. Conversely, since the larger quantity of fire, according to

¹⁰ To make my point more clearly, I have used comparatives throughout this paraphrase for the oppositions of size, weight and ease or difficulty of movement. Theophrastus has only one comparative in these two lines (*ῥᾶλλον*, 526.7).

¹¹ Ch. IV § 3, esp. pp. 72ff. above. See also the footnote following this.

Aristotle, moves away from the centre and towards the circumference more quickly, Theophrastus supposes that it should therefore be accounted as easier to move.

The larger quantity of fire is thus more difficult to move away from the circumference, and easier to move away from the centre.

The *logos* which correlates size with ease or difficulty of movement—the smaller quantity is easier to move, the larger quantity is more difficult to move—will therefore be true, or will ‘apply’, to the measurement of fire at the circumference, and it will not apply to the measurement of fire at the centre, precisely as Theophrastus’ formulation requires.¹²

§ 3. THE SECOND ‘LOGOS’

(i)

What then is Theophrastus’ second *logos*?

We might perhaps be tempted to think, following Diels’ suggestion, that the formula I have just put forward already supplies not one *logos*, but two: (1) the smaller body is easier to move, (2) the larger body is more difficult to move. The two *logoi* would then be simply the correlation of size with ease or difficulty of movement.

Fortunately we can tell from the final sentence of the quotation placed at the beginning of my chapter that this is not Theophrastus’ intention. For there Theophrastus tells us that ‘the same is also true in the case of earth, for the larger quantity is carried from above to here’, i.e. from circumference to centre, ‘more quickly’ (*Dox.* 526.12-13).

¹² We can therefore complete the schema offered earlier (p. 250 above), and also now present it more simply. For Theophrastus, a larger quantity of either element moves more slowly, and is more difficult to move, *away from* its natural place or its parent body; and moves more quickly, and is easier to move, *towards* its natural place or its parent body.

One crucial consequence. In my analysis of the *Timaeus*, I argued that the calculation of resistance for earth measured at the circumference and for fire measured at the centre *either* was missing from Plato’s theory altogether *or* was there thought of, implicitly, as the same for an element which is moved away from its proper place, in the sense that it would require a greater effort to keep the larger quantity of either element from returning to its like: see above ch. IV § 3, pp. 70-5. The notion of resistance which may be implicit in Plato’s original theory is therefore the *opposite* of the notion of resistance which I now suggest is implicit in Theophrastus’ criticism of Plato. (1) For Plato, the larger quantity of fire, to take only this example, is more difficult to drag away from its parent body and would also be *more difficult* to hold back from returning to its parent body. (2) But for Theophrastus, or so I would suggest, ease and difficulty of movement are calculated according to Aristotle’s beliefs on speed: the larger quantity of fire moves more slowly away from the circumference and is therefore more difficult to move in the same direction; it moves more quickly towards the circumference and would therefore be *easier* to move in the same direction. See further pp. 260-4 and 270-4 below.

When Theophrastus writes that 'the same is true for earth', I take him to mean that, for earth as for fire, there will be two *logoi*, which will apply in the one place, and not in the other. Now if that is so, then the sentence which follows, introduced by γάρ, must presumably be intended to express, or to be part of, the two *logoi*. But what we find, in the sentence which follows, is not the correlation of size with ease or with difficulty of movement, but instead the correlation of size with speed: the larger quantity of earth will be carried 'from above to below' more quickly.

I conclude that in the second *logos* size is aligned not with ease or difficulty of movement, but with speed. The larger quantity travels more quickly, as in the example Theophrastus has quoted of the movement of earth from circumference to centre. The smaller quantity will travel more slowly.

This *logos* will therefore again be true for fire at the circumference: the larger quantity of fire travels towards the circumference more quickly; the smaller quantity travels more slowly.

But, as I have already noted, the correlation of size with speed may also be applied to the calculation of fire which moves away from the circumference and towards the centre, and here it appears that the alignment of size with speed is no longer the same as it would be at the circumference: for the larger quantity of fire travels away from the circumference and towards the centre more slowly.¹³

The formula whereby the larger quantity moves more quickly and the smaller quantity moves more slowly is therefore *true* for fire at the circumference and *not true* for fire at the centre, as Theophrastus claims is the case for each of the two *logoi*.

(ii)

But where is this second formula, or anything like it, to be found in the sentences *preceding* the introduction of the two *logoi*?

Apart from the correlation of weight with ease or difficulty of movement, the only sentence preceding the introduction of the two *logoi* is the assertion that the more fire there is, the lighter it will be. But what has this to do with speed?

The idea that a larger quantity of fire is lighter than a smaller quantity is for Aristotle determined by, and expressed in, the belief that a larger quantity of fire travels upwards more quickly than a smaller quantity.

Theophrastus is imbued with Aristotle's philosophy. When he writes, earlier in the present passage of criticism, that in their upward movements fire and air 'both are light, and appear to be so' (... κοῦφα καὶ

¹³ Arist. *De caelo* iv 2, 308b18-21; cf. p. 249 above.

ἔστι καὶ δοκεῖ), one may suspect that he actually sees the upward movement of fire as light, in accordance with his Aristotelean philosophy.

Perhaps only those who have themselves been subjected to the grip of a powerful and subtle, if perhaps in part erroneous, philosophy can appreciate the tyranny of theory over experience, and perhaps more particularly the way in which one part of a familiar statement of theory can seem to carry with it, or even actually to be in itself, an expression of the whole.

It is therefore, I suggest, in the sentence immediately preceding the introduction of the two *logoi* that Theophrastus sees by implication, not only the correlation of weight with size, but no less the correlation of weight and size with speed.

(iii)

I conclude that the two *logoi* are to be identified as the correlation of a larger and a smaller body with ease or difficulty of movement and with speed.

1. The former *logos*: the larger quantity is more difficult to move, the smaller quantity is easier to move.
2. The latter *logos*: the larger quantity moves more quickly, the smaller quantity moves more slowly.

It may well be objected that this abrupt, and even mechanical, attempt to identify the two *logoi* raises more questions than it can hope to answer. In particular, it may be thought implausible that from Theophrastus' statement that the larger quantity of fire is the lighter I have sought to extract the formula that the larger body moves the more quickly, despite the fact that this correlation does not appear explicitly until Theophrastus' account of earth, after the initial introduction of the two *logoi*. Equally, it may be thought implausible that in the initial statement of Plato's theory I have sought to replace the qualification of weight with a qualification of size.

But if we look back at the passage as a whole, I think it is possible to see how the presence of the two *logoi*, in the form in which I have uncovered them, will have seemed to Theophrastus to have been reasonably apparent in the context of his criticism up to this point.

The main point to appreciate, I suggest, is that the two *logoi* are essentially the two criteria by which Plato and Aristotle determine the recognition of heavy and light.

1. Plato takes as his criterion whether a body is difficult, or easy, to drag into a region other than its own.

2. Aristotle takes as his criterion—not, for the extreme elements, of weight as such, but as the criterion for degrees of weight—whether a body travels more quickly or more slowly towards its natural place.

The *first*—the 'former'—*logos* has therefore been implied in Theophrastus' initial definition of Plato's theory, and it has been repeated at the beginning of his passage of criticism.

The *second*—the 'latter'—*logos* has been implied by Theophrastus in his assertion that by their movements towards the places that are natural to them fire and air 'both are, and appear to be, light', and more particularly by his assertion, immediately before the introduction of the two *logoi*, that the larger quantity of fire is the lighter.

From these two criteria we must detach the notion of weight. Theophrastus does this explicitly for his statement of the correlation between size and speed for earth. We must do the same for the correlation between size and ease or difficulty of movement.

For Theophrastus believes that the larger quantity of fire is more difficult to drag away from the circumference, but not that it is heavier therefore. If the first *logos* is to 'fit', or to be true of, fire at the circumference, it must be expressed therefore as a correlation of ease or difficulty of movement with size only, and not with weight.

(iv)

A second, and no less essential point.

Since Theophrastus tells us that the two *logoi* are true of fire when measured at the circumference, but not of fire which is measured at the centre, we must therefore express the two *logoi*, as I have done, in a form which is independent of any explicit reference to place or to direction of movement.

For according to Theophrastus the larger quantity of fire (to take only this example) will always move more quickly towards its natural place, and will always move more slowly away from it. Therefore once this 'alternative' qualification of direction is added to the correlation of size and speed it is impossible to say that the resulting formula is 'true' at the circumference and 'not true' at the centre.

In order to achieve this result, we have to take the *logos* as supplying solely the correlation of speed with size, and as then being applied, at the circumference, to movement towards the circumference, and at the centre, to movement towards the centre. Only so will it be the case that the correlation of size with speed (the larger body moves more quickly) will be true, for fire, at the circumference, and not true, for fire, at the centre.

The same must be the case for the correlation of size with ease or difficulty of movement. Theophrastus would suppose that it is always more difficult to move a larger quantity of fire away from its natural place, and easier (on the interpretation I have offered) to move a larger quantity towards its natural place. For the one *logos* to be 'true' at the circumference and 'not true' at the centre, we must again therefore detach the reference to direction, and take as our *logos* solely the relation of size to ease or difficulty of movement: the larger body is more difficult to move, the smaller body is easier to move.

It will then be true that this *logos* 'applies' at the circumference, and not at the centre. At the circumference, the larger quantity of fire is more difficult to move (away from the circumference). At the centre, the larger quantity is easier to move (away from the centre).

For the construction of his two *logoi*, Theophrastus asks us in effect to abstract the bare notional criteria of weight—speed and ease or difficulty of movement—employed by Aristotle and by Plato, and to attach them solely to a difference of size or quantity in the element moved, independently of the conclusion, which body is heavy and which is light, and independently also of their application to a particular place, whether centre or circumference.

(v)

I summarise.

There are two *logoi*, Theophrastus tells us, which are true, or which will 'apply', to the measurement of fire at the circumference, but which are not true, or which will not 'apply', to the measurement of fire at the centre.

Earlier interpretations have erred in seeking to implicate weight directly in the expression of the two *logoi*. This is impossible: for Aristotle's theory, shared by Theophrastus, is that fire (to take only this example) has a fixed weight, wherever it may be. Thus the description of the larger quantity of fire as heavier (Plato's theory) or as lighter (Aristotle's theory) cannot, for Theophrastus, be 'true' at the circumference, and 'not true' at the centre. The larger quantity of fire, so Aristotle and Theophrastus believe, is lighter in *both* places, and it is heavier in *neither* place.

Theophrastus' intention is clear from his account of earth: 'the larger quantity travels from above to here more quickly' (*Dox.* 526.12-13). From the correlation of weight with size and with speed in Aristotle's theory, we extract only the correlation of size and speed. In this way we are able to 'reverse' the *logos* that the larger quantity of fire moves more quickly: this is 'true' of fire which moves towards the circumference, and 'not true' of fire which moves towards the centre.

The correlation of size with speed supplies us with the 'latter' *logos*. The 'former' *logos* we are probably intended to extract, in a similar fashion, from Plato's description of the quantity of fire or earth which is harder to move as the heavier.

Again, Theophrastus cannot himself believe that the *same* quantity of fire could have a *different* weight (heaviness or lightness) at centre and circumference. The solution therefore is again to extract from Plato's definition, not the correlation of weight with ease or difficulty of movement, but only the correlation of size with ease or difficulty of movement: a larger quantity of either element is more difficult to move.

There is, however, for this *logos* the additional difficulty that Plato's original theory, at least in the reconstruction that I have given of it, either offers no indication of how we would measure the resistance of fire at the centre, or would have implied that the larger quantity of fire was more difficult to move at the centre as well as at the circumference. Theophrastus, I suggest, has derived the ease or difficulty of movement of fire at the centre from his own Aristotelean notion of speed. The larger quantity of fire is more difficult to move away from the circumference, and does so the more slowly: it moves away from the centre more quickly, and would therefore, Theophrastus supposes, be easier to move.

In this way we achieve an additional *logos* which is 'true' for fire at the circumference (the larger quantity is more difficult to move), and 'not true' at the centre (where the larger quantity is easier to move).

§ 4. THE 'LOGOI' OF FIRE AND EARTH

I have sought to identify the two *logoi* as follows.

1. The former *logos*: the larger quantity is more difficult to move, the smaller quantity is easier to move.
2. The latter *logos*: the larger quantity moves more quickly, the smaller quantity moves more slowly.

I assume that in testing the first *logos* we are intended to measure the movement of an element away from the circumference and away from the centre, while in testing the second *logos* we are intended to measure the movement of an element towards the circumference and towards the centre.

I turn then to test in practice the application of the two *logoi*.

(i)

I take first the calculation of fire.

Fire at the circumference

1. The larger quantity will be the more difficult to move away from the circumference, while the smaller quantity will be easier to move.

2. The larger quantity will move towards the circumference the more quickly, while the smaller quantity will move the more slowly.

Conclusion. When fire is placed at the circumference, the two *logoi* therefore will be true.

Fire at the centre

1. On the other hand, when fire is observed at the centre, then the larger quantity will be easier to move away from the centre, while the smaller quantity, by comparison, will be more difficult to move.

2. Equally, the larger quantity will move towards the centre more slowly, while the smaller quantity will move towards the centre more quickly.

Conclusion. In this sense, therefore, neither *logos* will be true, when fire is measured at the centre.

(ii)

I turn to the calculation of earth.

Earth at the circumference

1. The larger quantity of earth will be easier to move away from the circumference, the smaller quantity will be more difficult to move.

2. The larger quantity will travel more slowly towards the circumference, the smaller quantity will travel more quickly.

Conclusion. When therefore Theophrastus tells us that 'it is similar in the case of earth' (ὡσαύτως δὲ καὶ ἐπὶ τῆς γῆς), he must intend us to *reverse* his judgment on the truth of the two formulae in the case of fire. The two *logoi* will be true of fire which is measured at the circumference; but they will *not* be true when applied to earth measured at the circumference.

Earth at the centre

1. The larger quantity of earth will be more difficult to move away from the centre, the smaller quantity will be easier to move.

2. The larger quantity will move towards the centre more quickly, and the smaller quantity will move more slowly.

Conclusion. Again therefore we must *reverse* what Theophrastus has said about the truth of the two formulae in the case of fire. Neither formula will be true of fire measured at the centre. Both formulae *will* be true of earth measured at the centre.

(iii)

The critical purpose of Theophrastus' two *logoi* will be made apparent in the sentences which follow in the *De sensibus*, and which I shall consider therefore in my next section.

For the moment, I content myself with establishing the identity of the two *logoi*, and the literal sense of the application which Theophrastus makes of them.

1. The 'former *logos*' lies in the correlation of size with ease or difficulty of movement: the larger quantity is more difficult to move, the smaller quantity is easier to move.

2. The 'latter *logos*' lies in the correlation of size with speed: the larger quantity moves more quickly, the smaller quantity moves more slowly.

The two *logoi* apply the other way round to fire and to earth. The correlation of size with ease or difficulty of movement we apply to the movement of an element away from the centre and away from the circumference. The correlation of size with speed we apply to the movement of an element towards the centre or towards the circumference.

1. Both *logoi* are therefore true of fire measured at the circumference, and not true of fire measured at the centre.

2. Both *logoi* are true of earth measured at the centre, and not true of earth measured at the circumference.¹⁴

§ 5. THE LIMITATION OF PLACE

I have spent some time in disengaging the precise content of Theophrastus' two *logoi*, and their application to earth and fire at centre and circumference. So far the critical application—the purpose—of the two *logoi* has not been touched upon. There are in fact two distinct stages in the criticism which Theophrastus seeks to draw from the establishment of his two *logoi*: the first attaches to both fire and earth, and concerns the limitation of place (ὥστε ..., *Dox.* 526.13-14); the second attaches exclusively to earth, and contains Theophrastus' charge of inconsistency (οὐδ' ὁμοίως ..., *Dox.* 526.14-16). For the moment I concern myself exclusively with the criticism attaching to the limitation of place.

Thus in the first sentence of criticism following the introduction of the two *logoi*, Theophrastus writes that, 'as a consequence' of the two *logoi*—and, I may now add, their diverse application to fire and earth at the centre and at the circumference—'earth and fire', in Plato's theory, 'are not heavy and light respectively in a fixed or an absolute sense, but each will be so only in relation to a particular place', *De sens.* 88 (*Dox.* 526.13-14): ὥστε οὐχ ἀπλῶς ἡ γῆ καὶ τὸ πῦρ ἐστὶ τὸ μὲν βαρὺ τὸ δὲ κοῦφον, ἀλλ' ἐκάτερον πρὸς τὸν τόπον.

¹⁴ For further possibilities in the interpretation of Theophrastus' two *logoi*, see Note 10, pp. 404-9 below.

(i)

In considering the precise meaning of this sentence, we need more than ever to beware of attributing to Theophrastus more than he actually says.

Thus Taylor—for reasons that I shall consider in more detail in my next chapter—takes Theophrastus' sentence as a statement, indeed a re-statement, of his own interpretation of the theory of the *Timaeus*, whereby the larger quantity of fire is heavier at the circumference and lighter at the centre.¹⁵

But this is not at all in fact what Theophrastus says.

The two *logoi*, I have argued, do not in themselves include the calculation of weight, nor a specification of place. They express only the correlation of size with speed, and with difficulty or ease of movement. It is only in the present sentence that the two *logoi* are taken as an expression of weight. And the point of Theophrastus' criticism, in this present sentence, is that the two *logoi* will act as an expression of weight only if they are tied to a limitation or a specification of place.

Thus the contrast intended by the opposition between 'not in a fixed or an absolute manner' (οὐχ ἀπλῶς) and 'each in relation to a specific place' (ἐκάτερον πρὸς τὸν τόπον), is not, it seems to me, that a larger quantity of fire, for example, will have different determinations of weight in different places, as Taylor supposes.

On the contrary, the point will be that Aristotle's definition of lightness, for example, will be true of fire, wherever fire happens to be located; but that Plato's definition, according to Theophrastus' present criticism, will be true of fire only in relation to the circumference.

This is the immediate lesson of the fact that the two *logoi* are true, or will 'apply', at the circumference, for fire, but not at the centre. If our definition of weight employs the rule that the larger quantity is more difficult to move, while the smaller quantity is easier to move, then this will be true, it will 'fit', only for an element which is being moved away from its natural place, as indeed it does in Plato's own definition of weight.

For if we adopt the rule, which Theophrastus attributes to Plato, that the body which is more difficult to move is heavier, then the larger quantity of fire will be more difficult to move at the circumference, and will therefore, on Plato's theory, be heavier; but, according to Theophrastus' present criticism, the larger quantity will no longer be more difficult to move and will no longer therefore be heavier when fire is measured at the centre.

¹⁵ Stratton, 216-18; cf. pp. 267ff. below.

It is true that from this criticism we can easily reach the conclusion that, if the larger quantity of fire is *easier* to move at the centre, it should be lighter, so that the larger quantity of fire would then be heavier at the circumference and lighter at the centre. But Theophrastus does not add that conclusion. His point so far is simply that Plato has failed to provide a definition which will be true of the weight of fire or of earth simply, or universally. His definition is a definition of fire only as it is measured at the circumference, and of earth only as it is measured at the centre.¹⁶

(ii)

The instructive parallel—the parallel which 'the latter *logos*' must, I think, be intended to make us dwell upon—is that with speed of movement.

If our definition of weight employs the rule that the larger quantity of fire, or of earth, moves more quickly, then again this will be true only of fire when it is measured moving towards the circumference, and of earth when it is measured moving towards the centre. A definition of weight therefore which is tied to 'the latter *logos*' will be true only of fire or earth measured in a particular place. It will not be true of fire or earth universally.

For again the larger quantity of fire (to take only this example) will move more quickly towards the circumference, but it will move more slowly towards the centre. If therefore our rule is that the quantity which moves more quickly is lighter, then the larger quantity of fire will be lighter at the circumference, but it will no longer be so at the centre: for at the centre, and measured as moving towards the centre, the larger quantity will no longer be the quantity which moves more quickly.

¹⁶ Strictly the new flexibility in Theophrastus' definition would allow us to interpret *ἐκάτερον πρὸς τὸν τόπον* as meaning not necessarily 'each in relation to its own place', but 'each in relation to a particular place'. For if (to continue the example in the text) we were to start from the definition of the larger quantity of fire at the centre as easier to move and as lighter then it would again be true that the same quantity of fire would no longer be easier to move and would therefore no longer be lighter at the circumference.

Equally, we could take the Aristotelean and not the Platonic definition as our starting-point: the larger quantity of fire, which moves more quickly towards the circumference, is lighter (not heavier), but the same quantity will no longer move more quickly towards the centre, and at the centre it will therefore no longer be lighter.

The point is simply that whichever definition we start from, and whichever place we relate it to, the result will no longer be the same when we attempt to apply the same definition at a different place. In taking as my example the definition of the fire which is harder to move at the circumference, and which is thought of therefore as heavier, I have simply chosen the example which is psychologically the most plausible (since this is in fact the correlation employed by Plato). Logically, the argument would work as well, starting from any other example.

(iii)

In fact, of course, Aristotle's own theory does employ speed as a criterion of weight. But according to Aristotle's own theory, at least as far as the extreme elements, fire and earth, are concerned, speed serves not as the *primary* criterion of weight, but only as a *secondary* criterion, and even then not quite in the simple form in which it appears in 'the latter *logos*'.¹⁷

Thus for Aristotle fire and earth are defined as heavy or light 'absolutely', because either element moves in only one direction: wherever it is, fire will move 'up' and earth will move 'down', in so far as their movement is a natural movement, until either element comes to rest, each in its proper place.

Speed, in Aristotle's theory, will determine not whether fire and earth are in themselves light or heavy, but solely whether one portion of fire or earth is more light or less light, more heavy or less heavy, in relation to another.

1. Thus fire is light absolutely, because it moves, by nature, always and only upwards; a larger quantity of fire is lighter than a smaller quantity, because it moves upwards more quickly.

2. Earth, similarly, is heavy absolutely because by nature it moves always and only downwards; a larger quantity will move more quickly downwards, and will therefore be heavier than a smaller portion.

Speed therefore, in Aristotle's theory, is subordinate to the 'absolute' definition of weight according to place: for it is only once an element has been already defined as heavy or as light absolutely, according to its movement up or down (i.e. towards the circumference or towards the centre), that the calculation of speed, whereby the larger quantity moves more quickly in the same direction, may then be employed to define the larger quantity as respectively heavier or lighter.

Theophrastus' point I take to be that on Plato's theory the *secondary* criterion of weight, a difference of speed for different quantities, has usurped the role of a *primary* criterion of weight.

For if (thinking only of the example of fire) we make the quantity which moves more quickly the lighter, independently of the definition of 'absolute' weight, then this will be true of fire when it is measured at the circumference, moving towards the circumference; but at the centre the

¹⁷ My restriction on the use of speed as a secondary criterion of weight, as being so 'at least' for the extreme elements, here as earlier (p. 204 n. 15 and p. 255 above), is designed to take account of Aristotle's use of speed for the definition of relative weight: a tricky question, which I explore in my third volume.

larger quantity of fire will move more slowly, towards the centre, and if weight is still defined primarily by speed, and independently of a definition of 'absolute' weight, then the larger quantity will no longer be lighter.

(iv)

And yet if it is taken only so far there appears to be an element of obvious sophistry in Theophrastus' criticism.

Plato's original definition, as recorded by Theophrastus both in his brief exegesis of Plato's theory, and in his opening criticism of it, had included the qualification that the heavier body was more difficult to move 'into a region other than its own' (εἰς τὸν παρὰ φύσιν τόπον or πρὸς ἄλλότριον τόπον, capp. 83 and 88). How has Theophrastus been able to reverse this qualification, as in effect he has done on the interpretation that I have given of his criticism, so as to conclude that measured at the centre a larger quantity of fire would no longer be heavier, because there it would be easier to move *towards* its own place? In particular, how can Theophrastus think himself justified in foisting this contradiction upon Plato, when in his own theory he would allow that a quantity of fire which moves more quickly in one direction will indeed move more slowly when it is travelling in the opposite direction?

The more immediate answer lies in Plato's failure to specify, in any explicit way, the measurement of resistance, for fire at the centre or for earth at the circumference. This failure has allowed Theophrastus to graft Plato's (incomplete) account of resistance onto his own (complete) account of differences of speed.

Theophrastus' intention, or so I have suggested, is that measured at the centre the smaller quantity of fire would move more slowly away from the centre and would therefore be reckoned as more difficult to move than a larger quantity.

This therefore leads to the contradiction that measured at the centre ease and difficulty of movement have been aligned with what—for Aristotle and for Theophrastus—is 'natural' movement, whereas at the circumference they are aligned with movement by constraint.

1. Thus on Aristotle's theory the larger quantity of fire moves away from the centre more quickly, since in this direction it is moving towards its 'natural' place. Theophrastus supposes, or so I have argued, that on Plato's theory the larger quantity of fire should therefore be easier to move away from the centre. The smaller quantity moves more slowly in the same direction, and is reckoned therefore as more difficult to move.

2. But at the circumference the larger quantity of fire, on Plato's theory, is more difficult to move, since it is being pulled away from its parent body. And on Aristotle's theory the larger quantity of fire will move more slowly away from the circumference, since it is moving away from its 'natural' place, and its movement therefore is movement by constraint. The smaller quantity is easier to move in the same direction, and moves more quickly.

Hence the contradiction: the body which is easier to move, and which moves more quickly, away from the circumference (a small quantity of fire) is no longer the body which is easier to move, and which moves more quickly, away from the centre.¹⁸

(v)

But this more immediate answer, it will be said, serves only to highlight the chicanery in Theophrastus' criticism. Even granted the reconstruction I have proposed, why does Theophrastus not allow that for the larger quantity of fire to be more difficult to move at the circumference and easier to move at the centre is no more anomalous than the equivalent 'contradiction' in Aristotle's own theory whereby the larger quantity of fire moves more quickly towards the circumference and more slowly away from it?

The answer to this lies, I suggest, in Theophrastus' assertion, in his preliminary exegesis of Plato's theory, that according to Plato 'heavy and light are not to be defined by up and down' (cap. 83). Plato's refusal to allow that the circumference is 'up' and the centre 'down' leads, for Theophrastus, directly to his inability to define fire and earth as respectively light and heavy absolutely; and that inability leads in turn to Plato's failure to secure for his criterion of ease or difficulty of movement any meaning independent of the measurement of earth at the centre and of fire at the circumference. For the equivalent 'contradiction' in Aristotle's account of speed, whereby fire moves more quickly towards the circumference, in a larger quantity, and more slowly away from it, is resolved precisely because the difference of speed is subordinated to a concep-

¹⁸ *Nota bene.* The contradiction results from Theophrastus' assumptions about resistance. In Plato's own theory, I have argued, *either* we do not measure fire at the centre at all, *or*, if we do, then the larger quantity calls for a greater expenditure of effort on our part, just as it does when we measure quantities of fire at the circumference: for it will require more effort on our part *both* to remove a larger portion of fire from the circumference *and* to prevent a larger portion of fire returning to the circumference. Theophrastus, I have argued, takes the opposite view: a larger quantity of fire is easier to move at the centre, because, in Aristotle's theory, the larger quantity of fire moves more quickly towards its natural place. Cf. p. 252 n. 12 above.

tion of 'absolute' weight, which is itself tied to a conception of 'absolute' place. Once that guarantee is removed, so to speak, then speed and ease or difficulty of movement have to act alone as determinants of weight, dependent solely upon their correlation with size, and independently of their relation to movement 'up' and 'down'. For with no 'absolute' conception of space there is, so at least Theophrastus would believe, no means of measuring the movement of fire 'up' or 'down'. We can know only that the larger quantity is easier or more difficult to move; moves more quickly or more slowly. And that knowledge will be different, at the centre and at the circumference. Fire which is light at the circumference will therefore no longer be so when measured at the centre.

(vi)

I conclude that if we keep precisely to the terms of Theophrastus' present criticism, then there is still no confirmation for Taylor's thesis that the larger quantity of fire or earth is heavier at the circumference or the centre, respectively, and lighter in the 'opposite' place.

For Theophrastus' present criticism still conforms to the facts of Plato's analysis in the *Timaeus*, in so far as Plato does there describe only the calculation of fire at the circumference and of earth at the centre. This is reflected in Theophrastus' *précis* of Plato's theory, whereby the heavier body is more difficult to move into an alien region, and the lighter body is easier to move.

Theophrastus' present criticism is designed to isolate a fairly obvious deficiency resulting from this method of analysis: that it does not provide a universal definition of weight, but a definition of weight that is tied to the calculation of an element in a particular place.

For if we extract from Plato's definition simply the correlation of size with difficulty or ease of movement—or even if we add the more typically Aristotelean correlation of size with speed of movement—then these two correlations will apply only to an element which is measured in relation to its proper place. They will not apply to an element which is measured outside its proper place, and they cannot therefore provide a sufficient basis for a universal or absolute definition of weight.

For the quantity which is easier to move in the one place—a smaller quantity of fire away from the circumference—is not the quantity which is easier to move in the 'opposite' place. The quantity of fire which is lighter at the circumference will therefore no longer be so when this same criterion is applied to it at the centre.

Admittedly, from this it is a short step to claiming that what is light in one place will be heavy elsewhere. But that step has not yet been taken.

Theophrastus' point so far is solely that the definition which makes a body light or heavy in one place will not do so elsewhere.

Aristotle's own theory, so Theophrastus believes, escapes from this 'contradiction' by starting from the establishment of 'up' and 'down' as opposite locations existing independently of the element which occupies them. This opposition serves as the primary basis for Aristotle's definition of weight. At least in relation to the extreme elements, speed of movement (and by implication, ease or difficulty of movement) serves only as a secondary criterion, for establishing different degrees of heaviness or lightness; while even so the correlation of size with speed of movement, whereby the larger quantity moves more quickly, is true, in Aristotle's own theory, only of an element which is moving towards its natural place, while for an element which is moving away from its natural place allowance is specifically made for the opposite correlation.

This distinction may seem obvious. But it cannot attach to Plato's theory, so Theophrastus' present criticism implies, because without a theory of 'absolute' space there can be no means of testing whether the movement of an element is towards, or away from, its natural place. Plato's relativistic conception of space allows us, according to Theophrastus' present criticism, to isolate only the association of speed, or of ease and difficulty of movement, with size. But this correlation will be different at the centre and at the circumference. Therefore if our definition of heavy or light relies solely on the association of size with speed, or with ease or difficulty of movement, as it has to if we forego the distinction between circumference and centre as respectively 'up' and 'down' in an absolute sense, then the quantity of fire which is lighter at the circumference will no longer be so when measured at the centre.

CHAPTER FOURTEEN

THEOPHRASTUS: THE CHARGE OF INCONSISTENCY

§ 1. EARTH 'HERE' AND 'THERE'

The second critical conclusion which Theophrastus draws from his establishment of the two *logoi* applies not to earth and to fire, but solely to the measurement of earth.

Theophrastus writes as follows, *De sens.* 88 (*Dox.* 526.14-16): οὐδ' ὁμοίως ἐνταῦθα καὶ κεῖ (Diels, καὶ codd.) τὸ γεῶδες, ἀλλ' ἀνάπαλιν· ἐνταῦθα μὲν τὸ ἑλαττον, ἐκεῖ δὲ τὸ πλέον ἔχον τῶν ὁμογενῶν κουφότερον.

I paraphrase:

'Thus earth is not consistently <heavy or light> "here" and "there" <i.e. when measured at the centre and when measured at the circumference>, but a different way round <in each place>.

'For "here" <on earth> it is the quantity with the smaller number <of like constituents which is lighter>, but "there" <at the circumference> it is the quantity with the larger number of like constituents which is lighter.'

At last the Taylolean thesis has issued from a mouth other than Taylor's own. But so confident is Taylor that his thesis has not only underlain the whole of Theophrastus' previous criticism, but has been culled from the lips of Plato himself, that he is totally unaware of the uniqueness of the occasion, and he does nothing to celebrate, or to exploit, it. He writes simply:

'This is again a correct account of what Plato holds, but is meant to be felt as a paradox because it contradicts the δόξα (shared by Aristotle and Theophrastus) that earth is heavy ἀπλῶς'.¹

It is in fact essential to appreciate that this is the first, and the only, time that any ancient author attributes, or appears to attribute, to Plato the thesis that earth *differs* in weight according to the direction of its movement. This is therefore a striking, and an important, passage, and it is largely in anticipation of it that I have dwelt as long as I have done on Taylor's thesis, and particularly on the account that he offers of Theophrastus' critique of Plato's theory.

It is therefore to Taylor's account of the two *logoi* that I must first return.

¹ Stratton, 218

(i)

Taylor claims that the two *logoi* are that the heavy is what is difficult to move into a foreign region, and that the light is what is easy to move. Taylor then argues that the larger quantity of fire is more difficult to move at the circumference, and is therefore heavier, while at the centre the larger quantity is easier to move, and is therefore lighter. In this way, Taylor concludes, 'Plato's two statement are exactly reversed'.²

But there is a confusion in this argument. For Taylor has not 'reversed' the *logos* that what is heavy is difficult to move. This remains true of the larger quantity of fire measured at the circumference, and of the smaller quantity when measured at the centre.

What has been 'reversed' is the correlation of weight with size: the larger quantity of fire is heavier at the circumference, because there it is more difficult to move, and the smaller quantity is heavier at the centre, because in that position it is the smaller quantity which is more difficult to move.

But as I have noted, for Theophrastus to be able to assert that the two *logoi* are true, for fire, at the circumference, but not at the centre, they must exclude the correlation of weight with size. For Theophrastus believes that the larger quantity of fire is in fact lighter.

1. If therefore the correlation is that the larger body were heavier, Theophrastus would be unable to agree that this was so at the circumference.

2. If, on the other hand, the larger body were lighter, Theophrastus would be unable to deny that this was so at the centre.

Taylor's account of the *logoi* cannot therefore be correct.

I have nonetheless rehearsed Taylor's account of the two *logoi* at this point, because it explains the ease with which he finds his own interpretation of Plato repeated in both the criticisms which follow the introduction of the two *logoi*.

From Taylor's point of view, the introduction and the application of the two *logoi*, and the two sentences of criticism, what I have called the limitation of place and now the charge of inconsistency, are all simple re-statements of the same theme, 'obvious applications of Plato's principle', which Theophrastus' reader is meant to see as 'a *reductio ad absurdum*' of Plato's theory, 'a paradox', 'an evident absurdity'.³

But not only is it generally implausible, it seems to me, that Theophrastus should be content simply to re-state Plato's theory:

² Stratton, 216-17.

³ Stratton, 217-18.

Taylor's naïve assumption completely blunts the sequence of thought which follows from the introduction of the two *logoi*.⁴

(ii)

There are three distinct stages in the second part of Theophrastus' criticism (*Dox.* 526.10ff.).

Theophrastus' initial point (*Dox.* 526.10-13) is that the two *logoi* do not apply to an element outside its own region.

From this Theophrastus argues (*Dox.* 526.13-14) that a definition of weight based on either of the two *logoi*, or on both of them, will apply to an element only when it is measured in relation to its own region, and not absolutely or universally.

From this Theophrastus argues, in the present sentence (*Dox.* 526.14-16), that if we do employ the two *logoi* as a definition of weight for an element which is outside its own region, then the consequences are contradictory, at least in the case of earth.

The point I take to be that the smaller quantity of earth, since it is easier to move at the centre, is lighter, whereas at the circumference the larger quantity of earth would be easier to move, and the larger quantity should therefore be lighter.

We do therefore arrive at a charge of inconsistency. But we do so only in the final sentence of criticism which I have quoted (*Dox.* 526.14-16). And the charge of inconsistency is here related exclusively to earth.

These two qualifications are both of crucial importance.

(iii)

For the first and most important consequence of this reading of Theophrastus' criticism is that this final sentence of criticism *contradicts*

⁴ To find a clear statement of the charge of inconsistency, I have had to go back to Taylor's account of the two *logoi* and of fire (*Dox.* 526.10-12; Stratton, 216-17). For not only does Taylor simply take for granted that the charge of inconsistency which he has already seen in the account of the two *logoi* will apply equally to fire (*Dox.* 526.10-12) and to earth (*Dox.* 526.12-16); the statements which he makes specifically about earth display confusion bordering on incoherence. Thus in the case of fire (Stratton, 216-17), Taylor does at least tell us that the larger quantity of fire moves away from the centre 'more readily', and 'with a greater rush', and that fire therefore, for Plato, when measured at the centre, is lighter in the larger quantity. But for the comparison between different quantities of earth at the circumference (Stratton, 217), he tells us that: 'Since Aristotle assumes it will be granted that a big stone drops from the air more rapidly than a small one, an air-dweller would, on Plato's theory have to regard this movement as an *ascent* (as in Plato's own example the fire is said to 'rise' into the region of air) and call the small stone the heavier of the two.' But if we are to follow the analogy with Plato's own account of fire (*Tim.* 63B2-C5), then the conclusion should be that the body which moves *upwards* is *light*. See further Note 3, pp. 337-9 below.

the assumption that Theophrastus had made earlier in his criticism of Plato's theory.

For when Theophrastus complains that Plato's definition applies only to 'substances of an earthy nature' (*Dox.* 526.5-7), Theophrastus clearly assumes that the larger quantity of earth or of fire, in Plato's theory, is heavier, as is the larger quantity of earth in his own, and in Aristotle's, theory. This indeed, or so I have argued, is the point of his criticism. Plato has applied to earth and to fire the rule which Theophrastus believes will apply only to earth: namely that the larger body is heavier, and that the smaller body is light (or 'not so heavy').⁵

Hence too Theophrastus' claim (*Dox.* 526.7-10) that Plato's theory is refuted by the upward movement of fire and of air, where the larger quantity of either element—on Aristotle's theory—is shown to be lighter.⁶

Thus the behaviour of fire was introduced earlier (*Dox.* 526.7-10) precisely in order to refute Plato's theory by establishing a fact which Theophrastus now (*Dox.* 526.14-16) deliberately introduces as part, or consequence, of Plato's theory: namely that the larger quantity of an element can be the lighter.

But the difference—the crucial difference—is that Theophrastus does not, as Taylor claims, attribute to Plato the belief that *fire* is lighter in the larger quantity. The charge of inconsistency is related exclusively to earth: Theophrastus attributes to Plato what he sees as the absurdity that *earth* should be lighter in the larger quantity.

Hence the importance of my two qualifications: Theophrastus arrives at the charge of inconsistency only in the final stages of his criticism; and the charge of inconsistency is there made in relation to earth, and not in relation to fire. At this stage in Theophrastus' argument, the claim that, for Plato, earth should be lighter in the larger quantity contradicts the assumption of Theophrastus' earlier criticism: that in Plato's theory the larger quantity of either element is invariably the heavier.

For the essential point to appreciate is that Theophrastus' present sentence (*Dox.* 526.14-16) is intended, not at all as an 'obvious' restatement of Plato's theory, but on the contrary as Theophrastus' own—impossible and absurd—extension to Plato's theory.

(iv)

This will be clear, if we reflect carefully on the nature of the two *logoi*.

The two *logoi*, I have argued, effect a correlation of size with speed, and with difficulty or ease of movement.

⁵ Pp. 192-9 and 227-30 above.

⁶ Pp. 233-44 above.

We cannot, I think, exclude the notion of size from the expression of the two *logoi*. Admittedly, a *logos* might in itself perhaps be a simple phrase rather than a statement: 'what is difficult to move', 'what is easy to move', or 'what moves more quickly', 'what moves more slowly'. But of a simple phrase it would be impossible to say, in the case of fire, that it 'applies' at the circumference, but not at the centre. For at least in the case of speed the distinction of 'fast' and 'slow' will still 'apply' at the centre. The point is that it will 'apply' the other way round, at the circumference and at the centre.

We must therefore fill out difficulty or ease of movement to form a statement. And yet this statement must exclude the direct expression of weight. For according to Plato the quantity of fire which would be more difficult to move at the circumference, away from the circumference, is heavier; but Theophrastus believes that it is lighter. Theophrastus cannot therefore allow that Plato's *logos* would be true, for fire, at the circumference, and not true only at the centre.

Size is the only complement that we can add to the two *logoi*, in order to expand the simple notion of speed, and of ease or difficulty of movement, into a statement, and yet a statement that Theophrastus will find true for fire at the circumference, and false at the centre: the larger quantity of fire is more difficult to move away from the circumference, but it is not more difficult to move away from the centre.

And size is in fact the complement that we find contained in the expression of the second *logos*, when Theophrastus tells us that 'the larger quantity' of earth 'moves more quickly from the circumference to the centre'.

(v)

When Theophrastus first introduces the two *logoi*, the point he makes is that they will 'apply' to fire at the circumference, but not at the centre.

The equivalent point in the case of earth, I have argued, is that the larger quantity of earth is easier to move at the circumference, away from the circumference, and more difficult to move at the centre, away from the centre, and that therefore the former *logos* will 'fit', or will be true for, earth which is measured at the centre, and not for earth which is measured at the circumference.

The first conclusion which Theophrastus draws from this is that Plato's definition is applicable therefore only to an element which is measured in relation to a specific place (by implication, its own).

In the final sentence, before his summary, Theophrastus' point is that if we do seek to apply Plato's definition of weight, as that what is heavy is difficult to move, to earth which is measured outside its own region, then the larger quantity becomes lighter.

Hence the three distinct moments in Theophrastus' argument.

1. If the *logos* is that the larger quantity of earth is more difficult to move, then this will be true at the centre, and not at the circumference (cf. *Dox.* 526.12-13).

2. From this Theophrastus concludes that if the body which is more difficult to move is heavier, then the larger quantity of earth will be heavier at the centre, but not at the circumference.

From this point of view, Theophrastus' criticism is that Plato's definition of weight is true only for an element measured in relation to a particular place (cf. *Dox.* 526.13-14).

3. Theophrastus' final point is that if we seek to enforce the calculation of earth at the circumference, then the larger quantity will be easier to move, and will therefore be lighter.

From this point of view, the criticism is that the conclusions of Plato's theory are inconsistent (cf. *Dox.* 526.14-16).

(vi)

Once they have been spelt out in this way, there is an obvious difference between Theophrastus' criticisms, in this second half of his argument.

Thus in order to achieve the charge of inconsistency in his *final* argument Theophrastus has to expand the simple correlation of size with ease or difficulty of movement which had served as the structure from which to criticise Plato's theory in the *first* argument I have listed. Theophrastus does believe that the larger quantity of earth is heavier, at the circumference as well as at the centre. The *logos* which will not 'apply', for earth, at the circumference is solely that the larger quantity of earth is more difficult to move. The charge of inconsistency is achieved by *adding* to this *logos* a definition of weight: if the correlation of ease or difficulty of movement is treated as a definition of weight, then the larger quantity of earth, which is more difficult to move at the centre, and easier to move at the circumference, will be heavier at the centre and lighter at the circumference.

There is again a difference between the *second* and the *third* criticism. In his *second* criticism Theophrastus makes the point only that if we take the two *logoi* as a definition of weight then the larger quantity of earth will be heavier at the centre, but not at the circumference. It is only in the *third* criticism that Theophrastus draws the positive conclusion that at the circumference the larger quantity of earth would have to be lighter. Thus the form of Theophrastus' criticism, once the two *logoi* are taken as a definition of weight, is in effect that Plato's definition either will not app-

ly to an element outside its proper region (the *second* point), or that if it is made to do so then it leads to conclusions that are inconsistent (the *final* point).

Thus not only is there a change of position when weight is added to the two *logoi*; even the final sentence of criticism, the charge of inconsistency, is not simply a repetition of the criticism that has preceded, as Taylor supposes. The final criticism results from a new twist in the argument, which is designed to show that if we seek to repair what I have called the limitation of place in Plato's theory, then we are landed in ever worse confusion: namely the inconsistency that a smaller quantity of earth is easier to move and is therefore lighter at the centre, but that a larger quantity would be easier to move and would therefore be lighter at the circumference.⁷

(vii)

Once we have uncovered, in this way, the element of progression in Theophrastus' criticism, then we can the more easily see how Theophrastus has, as it were, dismantled Plato's original theory, and re-assembled it, but how, in this process, he has added an Aristotelean component of his own making.

Plato's refusal to allow that circumference and centre are 'absolutely' up and down Theophrastus takes as justifying the isolation, in Plato's theory, of a formula which would align ease or difficulty of movement exclusively with size and independently of movement away from the circumference or away from the centre. In then seeking to re-apply this formula to the measurement of an element in either place, including therefore fire at the centre and earth at the circumference, Theophrastus tacitly reconstructs Plato's conception of resistance according to his own Aristotelean notion of speed: the larger quantity of earth, since it moves more quickly away from the circumference, Theophrastus supposes would be easier to move. Theophrastus then seeks to employ this 'extend-

⁷ So far I have used only the Platonic *logos* in order to provide the charge of inconsistency: the criterion of ease or difficulty of movement, if used for a definition of weight, will make the smaller quantity of earth lighter at the centre and the larger quantity lighter at the circumference.

It will of course be possible to draw an exactly analogous conclusion from the Aristotelean *logos*: the smaller quantity of earth will move more slowly towards the centre, the larger quantity will move, or be moved, more slowly towards the circumference. If 'slowness' is used as a criterion for the smaller quantity of earth being lighter at the centre, then by this same criterion the larger quantity of earth would have to be reckoned as lighter at the circumference. As I have explained, Aristotle and Theophrastus *avoid* this conclusion, since for them a difference of speed is only a secondary criterion of weight, subordinate to their conception of absolute place: see pp. 262ff. above.

ed' formula for resistance as a definition of weight, with the result that the larger quantity of earth is heavier at the centre, as Plato had said it was, but lighter at the circumference.

Plato's *own* theory, I have argued, either neglected to specify the measurement of earth at the circumference and of fire at the centre, or had implied that the larger quantity of fire or earth, in being more difficult to hold back from returning to its native element, would still have been heavier, fire at the centre no less than at the circumference, earth at the circumference no less than at the centre.

(viii)

The only point we still need to appreciate is perhaps also the most important: why does Theophrastus single out the inconsistency in the case of earth, and not in the case of fire?

Why is it that Theophrastus points out that for both elements Plato's definition is restricted to a particular place, while the charge of inconsistency is made only in relation to earth?

The answer, I think, is simple.

Plato's own conclusion is that the larger quantity of earth is heavier. Aristotle, and Theophrastus, agree that this is so. The critical element, therefore, in Theophrastus' charge of inconsistency, lies in the assertion that if Plato's principles are applied to the measurement of earth away from its natural place then the larger quantity will be lighter.

The point is that formally the error lies in Plato's theory leading to results that are inconsistent. But humanly one element in the inconsistency is more important than the other. It is in the notion of the larger quantity of earth being lighter that Plato's inconsistency leads to a result which Theophrastus sees as false.

In the case of fire, things are the other way round. Plato starts from the assumption that the larger quantity of fire is heavy. The charge of inconsistency would therefore lead to the conclusion that the larger quantity of fire is lighter than a smaller quantity.

But this conclusion Aristotle and Theophrastus hold is *true*. There would be less point therefore in developing the charge of inconsistency in relation to fire, for the new and contradictory feature would in effect act only as a *corrective* to Plato's theory.

(ix)

I summarise.

When Theophrastus first introduces the two *logoi* his point is that they will 'apply' to the measurement of fire at the circumference, or of earth at

the centre, but that they will not apply to the measurement of either element in the place which is 'opposite' to it.

From this, Theophrastus' first conclusion is that Plato's definition of weight is restricted to the calculation of an element in a particular place, and will not apply to fire or earth 'simply' or 'universally'.

Theophrastus then argues that a smaller quantity of earth is lighter at the centre, but that a larger quantity would be lighter at the circumference. His point, I have argued, is that if we do apply the two *logoi* to the calculation of earth at the circumference, then the larger quantity would be easier to move, and that on Plato's theory it should therefore be lighter.

Theophrastus does not mean that Plato himself drew this conclusion from his theory. Theophrastus' initial point is precisely that Plato's definition is restricted to the description of earthy substances, where the larger quantity is invariably the heavier.

Theophrastus' point is that Plato's definition is restricted to the calculation of an element which is measured in its own place, and that if we do attempt to apply Plato's definition to the calculation of an element in the 'opposite' place—the calculation of earth at the circumference—then the results are inconsistent.

Do I need to point out how radically different all this is from Taylor's interpretation? In his reading of the *Timaeus*, Taylor simply takes for granted a feature of what is in fact the Aristotelean theory, namely that the larger quantity of fire is lighter. From this Taylor produces an interpretation of Plato, whereby the larger quantity of fire is lighter at the centre, and heavier at the circumference, and conversely that a larger quantity of earth is heavier at the centre, and lighter at the circumference. This interpretation happens to coincide with Theophrastus' final criticism of Plato, which Taylor therefore takes for granted as being confirmation—and which may indeed have been the secret origin—of his thesis.

But the truth is, I suggest, that Taylor has added an Aristotelean element to produce his statement of Plato's theory; while Theophrastus has used his Aristotelean philosophy to provide a refutation of Plato's theory. Both formulations are alike therefore in their apparent content. But they are opposed in their purpose. Taylor takes as a true expression of Plato's original theory what Theophrastus offers as an impossible and inconsistent consequence that he has himself chosen to draw out from Plato's theory.⁸

⁸ Taylor's theory is of course still the more elaborate of the two. Theophrastus' argument does not imply that earth, at the circumference, would be lighter than fire, which is Taylor's initial assertion (*cf.* pp. 221-2 above). Theophrastus limits himself to the com-

§ 2. SUMMARY

Theophrastus concludes his criticism thus, *De sens.* 89 (*Dox.* 526.16-18): ταῦτα δὲ πάντα συμβαίνει διὰ τὸ μὴ ἀπλῶς περὶ κούφου καὶ βαρέος, ἀλλὰ περὶ τοῦ γεώδους ἀφορίζειν.

In this summary of his criticism, Theophrastus returns to his original point. The impossible consequences of Plato's theory are the result of Plato's failure to define heavy and light in an absolute sense, and his offering an equation of weight and size which is in fact true only for earth and for substances that are made of earth.⁹

Theophrastus' reiteration of this principle at the conclusion of his criticism has one final, and important, lesson to teach us.

In the pair of sentences preceding, Theophrastus has in effect moved close to considering the problem that I spent some time on earlier: whether, or how far, Plato's theory was intended to include only the measurement of earth at the centre and of fire at the circumference, or whether it should be extended to include the calculation of fire and earth each in the place opposite to its own.

Now when Theophrastus first stated his criticism that Plato's definition applied only 'to earthy substances', it was at once followed by the observation that for these substances what was heavy did indeed appear the more difficult to move into an alien region, while the lighter portion would be easier to move (*Dox.* 526.6-7).

Theophrastus' repetition of this criticism, in an unchanged form, leads me to suspect that he still sees Plato's theory, as he had seen it in his original summary of Plato's belief, and in his opening criticism of the theory, as attaching exclusively to the movement of a body into an alien

parison of different quantities of the *same* element, as Plato himself had done in his analysis of resistance.

In Taylor's misunderstanding and misinterpretation of Plato, there is the added paradox that, although Taylor uses Aristotelean ideas to fill out his understanding of the *Timaeus*, nonetheless he has quite failed to master Aristotle's own theory. Thus I have already noted (p. 242 n. 22) Taylor's mistaken belief that, on Aristotle's theory, both air and fire are light absolutely (Stratton, 217: 'no air or fire <is> heavy'). In the final paragraph of his commentary (Stratton, 218), Taylor tells us that both earth and water are heavy absolutely: 'The main point to be clear on is that from the Aristotelian point of view ... earth and water are always heavy, no matter where you are supposed to be looking from.' Taylor is wrong on both counts. Aristotle's theory turns on the distinction between the absolute weight of the extreme elements (fire and earth) and the relative weight of the intermediate elements (air and water). The intermediate elements, unlike the extreme elements, can be characterised both as *light* and as *heavy*. Thus air and water rise in earth; they are therefore *lighter* than earth. They fall in fire, and are therefore *heavier* than fire. (See esp. *De caelo* iv 4, 311a22-9.) I have a strong impression that Taylor has not read beyond the criticisms of Plato in *De caelo* iv 2; while Stratton has obviously not dared to raise his eyes from Taylor's commentary, to see for himself what Aristotle has to say.

⁹ Cf. pp. 227ff. above.

region, i.e. of fire away from the circumference and of earth away from the centre.

That this should be so, despite the charge of inconsistency that follows from applying Plato's principles both to the calculation of earth at the centre and to the calculation of earth at the circumference, leads me to suspect that Theophrastus did not envisage Plato's final definition in its extended form. Theophrastus' behaviour is most simply explained, if we suppose that he read Plato's final definition solely as a summary of the movement of fire and earth into the 'alien air'.

This need not prevent us from ourselves seeing further implications in Plato's final definition, of the kind that I outlined earlier, in describing Plato's conception of weight as defined by resistance, whether the resistance that we feel in trying to drag an element away from its parent body, or the resistance that we feel in seeking to prevent an element from returning to its kindred.

But Theophrastus' behaviour should, I think, discourage us from seeking to make Plato's extension of his theory any more openly explicit than I earlier suggested that we should.¹⁰

§ 3. PARAPHRASE

I paraphrase as follows Theophrastus' two passages of exegesis (cap. 83) and of criticism (capp. 88-9):¹¹

Exegesis

'Plato says that one should not define "heavy" and "light" by "up" and "down": for these terms <"up" and "down"> have no existence in nature.

'Instead, "light" is what can easily be dragged into a region that is contrary to its nature, while "heavy" is what is difficult <to move into a region other than its own>.'

Criticism

'A further criticism.

Earthy substances

'Plato has defined what is heavy and what is light, not in an absolute <or simple> sense, but <only> for bodies that are of an earthy nature.

'For in the case of these bodies it does appear that what is heavy is with difficulty <brought into a region that is not its own>, while what is light is the more easily brought into a region other than its own: <which is how Plato seeks to define heavy and light>.

¹⁰ Cf. pp. 74-5 above.

¹¹ Diels, *Dox.* 524.26-8 (cap. 83), 526.5-18 (capp. 88-9).

Weight and quantity

'But <the same will not be true of fire and air, for> fire and air both are and appear to be light, in virtue of their movements to their proper regions.

'Consequently, <for fire and air> it will not be the case <in fact, as it has to be for Plato> that the body which has a smaller number of like parts is light, while the body that has the larger number is heavy.

'<This is true in fact only of earth; just the opposite is true of fire,> for the more fire that there may be, the lighter <it is, in the sense that it will travel upwards more quickly>.

The two 'logoi' and the measurement of fire

'The objection to Plato's theory is therefore that (ἀλλά) if fire is placed above <i.e. at the circumference> then the <two> formulae will be applicable, both the latter <the Aristotelean formula> and the former <the Platonic formula>.

'<According to the Aristotelean formula, the larger quantity of fire will move towards the circumference more quickly, the smaller quantity will move more slowly. According to the Platonic formula, the larger quantity will be more difficult to move away from the circumference, the smaller quantity will be easier to move.>

'However, here <on earth> neither formula <will apply>.

'<Contrary to the Aristotelean formula, the larger quantity of fire will move towards the centre more slowly, the smaller quantity will move more quickly. Contrary to the Platonic formula, the larger quantity will be easier to move away from the centre, the smaller quantity will be more difficult to move.>

The two 'logoi' and the measurement of earth

'The same will again be true in the case of earth.

'<According to the Aristotelean formula,> the larger quantity <of earth> will be carried from above to here <i.e. from the circumference to the centre> more quickly, <while the smaller quantity will be carried in the same direction more slowly. According to the Platonic formula, the larger quantity will be more difficult to move away from the centre, the smaller quantity will be easier to move. The two formulae will therefore be true, for earth, at the centre.>

'<But the two formulae will not apply to the behaviour of earth at the circumference. Contrary to the Aristotelean formula, the larger quantity of earth will move towards the circumference more slowly, the smaller quantity will move more quickly. Contrary to the Platonic formula, the larger quantity will be easier to move away from the circumference, the smaller quantity will be more difficult to move.>

The limitation of place

'Consequently, <if we reckon weight as sufficiently determined by speed or by ease and difficulty of movement, then> earth and fire are not heavy and light <respectively> in a <simple or> absolute sense: but each is so <only> relatively to the place <which is natural to it>.

'<For the two formulae will apply to the behaviour of earth at the centre, but not to the behaviour of earth at the circumference.>

'<And conversely both formulae will apply to the behaviour of fire at the circumference, but not to the behaviour of fire at the centre.>

The charge of inconsistency

'Nor indeed will an earthy substance be consistently <heavy or light> here <on earth> and there <at the circumference>, but the other way round.

'For here <on earth> the smaller quantity <will be> lighter <in so far as it is easier to drag the smaller quantity away from the centre>, while there <at the circumference> the quantity that has the larger number of like parts <would be> lighter <in so far as the larger quantity of earth would be easier to move away from the circumference>.

'<The same would be true on the Aristotelean formula: if the smaller quantity of earth is lighter because it moves more slowly towards the centre, then by the same criterion the larger quantity should be lighter at the circumference, since it is the larger quantity which moves in that direction more slowly.>

The final summary

'All these <confusing and impossible> consequences arise because Plato has not given a definition of heavy and light in a <simple or> absolute sense, but only for a body that is of an earthy nature <as I pointed out in my opening criticism>.'

CHAPTER FIFTEEN

AN INTERPRETATION OF PLATO'S THEORY

§ 1. CRITICISM IN ARISTOTLE AND THEOPHRASTUS

Aristotle's criticism of Plato, I have tried to show, turns in part on the separation of principle from 'fact'.¹ Both Plato and Aristotle, or so I have argued, believe that a larger quantity of fire would move, or be moved, away from the circumference more slowly than a smaller quantity; but whereas Plato's theory requires the larger quantity of fire to be reckoned as heavier therefore, Aristotle sees in this (largely imaginary) phenomenon proof that fire is lighter in the larger quantity.

In this instance, therefore, both philosophers agree upon the 'fact'; they differ over the principle which the 'fact' is supposed to embody.

1. For Plato, both fire and earth are heavier in the larger quantity, since in either case it is more difficult to move the larger quantity away from its parent body, and there is the clear implication that the larger quantity will therefore move, or be moved, away from the parent body more slowly.

2. For Aristotle, the larger quantity of earth alone is heavier, while fire is lighter in the larger quantity. Thus for Aristotle fire which is light absolutely moves upwards, i.e. towards the circumference, by nature, and the larger quantity therefore moves, or is moved, towards the circumference more quickly, and away from the circumference more slowly. By the same reckoning, earth which is heavy absolutely moves downwards, i.e. towards the centre, by nature, and is heavier in the larger quantity, in so far as the larger quantity moves, or is moved, more quickly towards the centre, and more slowly away from it.

The 'facts' therefore, at least as regards the movement of fire away from the circumference and the movement of earth away from the centre, are the same for Plato as for Aristotle. It is the explanation of the 'facts' which is different in either case.

(i)

This separation of 'fact' and principle allows us to follow a process which I believe is typical of Aristotle's criticism of earlier philosophers.

¹ Pp. 201ff. The account which follows is less closely tied to the details of the text.

1. In his criticism of Plato, Aristotle first isolates the principle that, on Plato's theory, the larger quantity of any element is heavier.
2. Once isolated, this statement of principle is given the meaning which it would have in Aristotle's own philosophy, and in this new sense it is then re-applied to the facts which it had originally been used to describe and explain.

Thus from Plato's principle that the larger quantity of any element is 'heavier', Aristotle draws the conclusion that the larger quantity of fire, on Plato's theory, should move, or be moved, towards the circumference more slowly, and away from the circumference more quickly: a 'fact' which both Aristotle and Plato agree is false.

(ii)

Essentially this same critical process is exemplified in Theophrastus' criticisms of Plato.

In his opening sentences, Theophrastus pursues the argument that Aristotle had chosen.

1. Theophrastus first isolates the principle that, for Plato, the body which is more difficult to move away from its own region, and therefore the larger quantity of either element, is heavier.
2. In Aristotle's philosophy this is true only of earth: earth, which is heavy absolutely, will be heavier in the larger quantity; but fire, which is light absolutely, will be lighter in the larger quantity.

Theophrastus therefore concludes that fire, which in Plato's theory is more difficult to move away from its own region in the larger quantity, and which, for Plato, is heavier therefore in the larger quantity, is (from Aristotle's point of view) no different in principle from substances that are of an earthy nature.

Again: Theophrastus has not denied the fact; he has denied the explanation of the fact. Both Theophrastus and Plato agree that fire in a larger quantity would move more slowly, or would be more difficult to move, away from the circumference. But for Theophrastus the larger quantity of fire is therefore lighter, since for fire movement away from the circumference is movement that is contrary to nature. Plato's conclusion, that fire therefore is heavier in the larger quantity, Theophrastus sees as collapsing the distinction between earth and fire, bodies which in Aristotle's philosophy have opposite forms of absolute weight, and as reducing fire to the status of earth.

This conclusion is arrived at because 'heavier', which in Aristotle's philosophy can apply only to earth (or to a body that has relative weight),

is allowed to retain this same sense in Plato's description of fire as 'heavier'.

In this initial criticism therefore Theophrastus has correctly uncovered the principle which underlies Aristotle's criticism of Plato, as he has also done, or so I have argued, in his repetition of Aristotle's criticism of Democritus.² In Theophrastus' criticism, as in that of Aristotle, 'heavier' is, so to speak, extracted from Plato's description of fire, endowed with the meaning which the word has in Aristotle's own philosophy, and re-applied to the description of fire, with the conclusion, for Aristotle, that in Plato's theory a larger quantity of fire will travel more slowly towards the circumference, and with the conclusion, for Theophrastus, that in Plato's theory fire therefore is no different, in principle, from earth.

(iii)

In the continuation of his criticism (the 'two *logoi*'), Theophrastus pursues a more elaborate criticism, which is nonetheless the same in kind.

1. Theophrastus now enlarges upon the use of speed in Plato's expression of his theory: the larger body is *more difficult* to move in one direction, and moves *more quickly* in the opposite direction.

2. This principle, or this pair of principles, Theophrastus then applies to a circumstance that had either been only implicit in Plato's original theory, or that had been neglected altogether: the measurement of earth at the circumference, and of fire at the centre.

Theophrastus argues that Plato's principle cannot be true of earth and of fire, if each element is measured both at the centre and at the circumference. The larger quantity of earth will be more difficult to move away from the centre, and will move more quickly towards the centre. But measured at the circumference the opposite will be true: the larger quantity will be *easier* to move away from the circumference, and will move, or be moved, *more slowly* towards it. Similarly, the larger quantity of fire will be more difficult to move away from the circumference, and will move more quickly towards it. But measured at the centre the opposite will be true: the larger quantity will be *easier* to move away from the centre, and will move, or be moved, *more slowly* towards it.

Theophrastus concludes that Plato's definition will be true therefore only of fire or of earth measured in a particular place (fire at the circumference, earth at the centre), and not of fire or of earth universally.

² For Theophrastus' repetition of Aristotle's criticism of Democritus, see vol. i, pp. 13, 132-50.

(iv)

The same criticism is then turned to a different use (the 'charge of inconsistency').

1. Theophrastus now returns to the principle that the body which is more difficult to move is *heavier*.

2. Again he applies this principle to the movement of earth at the circumference.

He now concludes that measured at the circumference a larger quantity of earth, since it would be easier to move, would have to be lighter on Plato's theory, *contrary* therefore to the designation which the larger quantity of earth is given, in Plato's own theory, when it is measured at the centre.

(v)

Thus in each of the criticisms that I have listed, from Aristotle and from Theophrastus, there is first as it were a process of contraction, whereby a principle is isolated from the 'facts' which it was originally intended to explain; and there is then a process of expansion, whereby the isolated principle is either *re-applied* to the facts which it had originally been designed to explain, but now employed in a new and altered sense, or *extended* to describe phenomena that the original theory had neglected.

Seen in this light, Aristotle's criticisms are neither 'pointless', as Professor Guthrie supposes, nor are they trivial and arbitrary, as Cherniss and Solmsen believe.³

Both Aristotle and Theophrastus have made an attempt to disengage principle from practice, to separate the criteria of weight that are implicit in Plato's theory from the use that Plato had made of those criteria in attempting to describe and explain the behaviour of particular substances.

Their subsequent re-employment of those criteria, in ways that Plato had not intended, or to phenomena that he had neglected, may be seen as an attempt to test those criteria independently of the particular circumstances for which they had initially been employed.

From this point of view, the isolation of principle, and its re-application, is understandable, and even perhaps, methodologically, justifiable, however alien the results may appear to *modern* notions of *historical* criticism.⁴

³ Guthrie, *De caelo* Loeb edn 334 n.a, cf. pp. 200ff. above. Cherniss, *ACPl* 136-9, 161-5, see esp. pp. 175ff. above. For Solmsen's agreement with Cherniss, *Aristotle's system* 280 n. 19, see above p. 79.

⁴ These paragraphs summarise the conclusions of the preceding chapters of Part Three of my essay; I have not repeated the references that may be found in the course of these chapters.

§ 2. PLATO AND DEMOCRITUS

Now very curiously, although Cherniss is so scathing in his treatment of Aristotle, the interpretation which results from his own approach to the text of the *Timaeus* is, in principle, not so very different from the interpretation which we find in Theophrastus and in Aristotle. For Cherniss also supposes that from the *Timaeus* there can properly be isolated some single statement of theory that will dispense with the need for giving serious attention to any other (seemingly discrepant) allusion to the subject that may be found elsewhere in the *Timaeus*.⁵

My own approach has been radically different: I have tried to show that Plato's intention is to present a single conception of weight by deliberately introducing the 'explanation' of weight into a succession of different contexts.

Nonetheless, my purpose has not been to attempt to portray Plato's theory of weight as somehow more sensible or more cogent, or even as more interesting, than it has been made out to be by scholars hitherto.

It is true, I do hope that the texts I have quoted and the analyses I have given of them will serve to dispel the common assumption that Plato's successive allusions to weight are a mere jumble of inconsistencies.⁶ But my aim here is not, in any simple sense, to 'defend' Plato's consistency, as though the historian of philosophy could in some way hope 'to take sides' in what can no longer be a living debate.

Attempts are sometimes made to rejuvenate Aristotle's physical philosophy, to prove that in some sense the principles of Aristotle's theories are, or can be, germane to the conclusions of modern science; and though the execution of this aim, in some hands, may not be foolish, the aim itself, in my opinion, is radically misconceived, at least if it is

This more general account of the style of criticism in Theophrastus and in Aristotle is not of course meant to be exhaustive. Also possible would be the conclusion that a term employed in a relative sense is shorn of its qualification, and employed, or implied temporarily in an absolute sense, before having attached to it a new and potentially contradictory qualification. Thus in Theophrastus' final criticism the body which for Plato is heavier is a body which is more difficult to move *away from its parent body*: Theophrastus suppresses the qualification, and replaces it with another, so as to yield the conclusion that earth which is easier to move away from the circumference (and so *towards* its parent body) will be lighter.

This manipulation of absolute and relative terms is a favourite device especially of Plato's earlier dialogues. I have chosen to present this same process as an attempt to separate a principle from the 'facts' in which it is enclosed, in order to try to counter the prevalent assumption that Aristotle's criticisms are merely captious, an assumption which takes no account of the ideological background to Aristotle's criticisms: the uniformity or the simplicity of matter (*cf.* pp. 192ff. above), the existence of absolute directions in space (*cf.* pp. 185ff. above).

⁵ See esp. pp. 157ff. above.

⁶ Note especially the quotation from Solmsen, p. 158 above.

presented, as it sometimes is, as all of a piece with an historical enquiry into Aristotle's philosophy.⁷

But in any case what is possible, with some show of reason, for Aristotle, is no longer possible for Plato. The principles which we might hope to extract from Plato's physical philosophy, as possessing some kind of permanent validity, would be hopelessly general, it seems to me; while even the judgment, quite frequently made, that Plato's theory of weight is in principle somehow more 'scientific', or even more 'true', than Aristotle's theory, seems to me still to require from the historian a judgment which fairly obviously bears little relation to the texts that must form, in part, the basis of his judgment.⁸

Nonetheless it seems to me both possible and useful to seek to interpret Plato's theory in other ways, through the comparison of particular texts, and through the comparison of Plato's theory with the theories both of his predecessors and of his more immediate successors. For 'retrospective' comparison does, I believe, add what is in one sense a non-historical dimension to a study of the history of ideas, although a dimension which falls short of any attempt to establish directly the truth or falsity of earlier ideas.

Deliberately 'retrospective' comparison, comparison of Plato's theory with that of Aristotle in order to clarify our understanding of the *earlier* theory, I must necessarily postpone until after my study of Aristotle, although I give some indications of my approach at the end of this chapter and in a separate Note.⁹

For the moment, in the remaining sections of this final chapter of my second essay, I seek to offer a very simple 'interpretation' of Plato's theory by returning to the ideas of weight that in the concluding chapter of my first essay I tried to show were characteristic of philosophical writing in the fifth century, and by attempting to consider Plato's theory of weight in the *Timaeus* as a probable reaction to the reconstruction that I have sought to establish of Democritus' theory.

(i)

In the concluding chapter of my first essay I noted that Democritus' use of *λεπτόν* to describe what is 'light' (as reported by Theophrastus) may be seen as a continuation of the earlier association (which

⁷ Examples of such studies, by Ashley and Weisheipl, may be found in the Bibliography.

⁸ The view I criticise was that of Alfred N. Whitehead, *The concept of nature* (Cambridge, 1920) 17ff., given forceful expression by Taylor, *Commentary* 441. In a similar vein, Philippon, "Ἦλη ἀνθρωπίνη 225, and of course many others.

⁹ See pp. 313-16 below, and Note 11, esp. pp. 427-9.

Theophrastus also alludes to) of things hot and cold, heavy and light, with differences of density. Democritus' more formal theory, which I have attempted to reconstruct from Theophrastus' report, and from passages in Aristotle, and in later authors, may then be seen as an adaptation of this same association to Democritus' theory of atoms and void.

1. The solid and unchangeable atoms cannot vary in density: their weight therefore is covariant with their size.
2. In compound bodies (either in bodies where the comparison of volume is left out of account, or in bodies which are taken for granted as of equal volume) weight is determined by the proportion of void.¹⁰

The feature which I did not comment on in Democritus' theory, but which comes to light once we compare Democritus' theory with that of Plato, is the *difference* which this seemingly simple theory establishes between the opposition of weight and other 'sensible' oppositions, for example the opposition of temperature. For Democritus *retains* in the case of weight what he *abandons* in the case of temperature.

(ii)

Thus Democritus' intention, we learn from Theophrastus, and from other authors, is that hot and cold should no longer be properties or powers intrinsic to the material from which the world is made, as they had been for other thinkers in the fifth century, but that they should become, in Theophrastus' expression, 'affections of sense': i.e. they should be seen as no more than the product, upon the sentient body, of the shapes or sizes of the atoms, and their disposition in space, while the atoms themselves should be entirely without any intrinsic differentiation of temperature.¹¹

But Democritus evidently does not extend this same theory to include the opposition of heavy and light.

It is true, as I noted earlier, that weight, for Democritus, is not regularly included with the *differentiae* of material 'substance': shape, position and arrangement, to which there are sometimes added differences of size.¹² But equally, heavy and light do not appear as properties which arise only from the conjunction of perceived object and percipient. The 'weight' of an atom is apparently a direct expression of its size: it is not, as heat is, a mere product of the conjunction between a certain size or shape of atom and a sensible percipient, although equally it is not some

¹⁰ Vol. i, esp. pp. 364ff.

¹¹ Theophrastus, *De sens.* 60 (DK 68A135): πάθη τῆς αἰσθήσεως. For Democritus' theory of sensation, see Guthrie *History* ii 438-49.

¹² Vol. i pp. 233ff.

additional character of atomic 'substance', of the same status as shape or size.

This uncertainty over the status or position of weight is resolved, at least in principle, in Plato's theory, where heavy and light, no less than hot and cold, are included among the *pathemata*. Weight, no less than temperature, is now conceived, or so it would seem, from the context of Plato's analysis, as dependent upon the conjunction of perceived object and percipient.

(iii)

This innovation gives rise to many questions, which I do not mean to explore here.

Fairly obviously, Plato's ability to make weight conform to temperature may be seen as in part the consequence—or perhaps the cause—of Plato's radically innovatory conception of material substances as dependent upon the 'geometrical' solids. The transition, in Plato's theory, from the 'abstractions' of geometry to the 'material' entities that underlie our sensible experience, was for Aristotle the major scandal in Plato's physical theory; and I do not think that Plato's own conception of that transition has been clarified by any modern scholar.¹³ But fairly clearly a system which adopts mathematical or geometrical entities as in some sense the originating particles of material substance is the more easily able to treat weight, no less than temperature, as a secondary and derivative phenomenon.

Conversely, Democritus' conception of the 'indivisibles', as distinguished by their solidity or by their hardness, would, I suspect, have acted to prevent the possibility of conceiving 'weight' as separable from material extension.¹⁴

Indeed it is, I suspect, the difficulty of conceiving of heaviness as no less an exclusively sensory phenomenon than 'hot' or 'sweet' that has led to what would seem to us to be the ambiguity in Democritus' system, where weight is at once something 'less' than the primary characters of material substance, shape and size, and yet is not merely an effect of the conjunction between perceived object and percipient.¹⁵

¹³ Attempts have been made notably by Wilpert, Schulz and Morrow, in works listed in the Bibliography. Cf. Arist. *De caelo* iii 1, 299a1ff.

¹⁴ For 'hardness' or 'solidity' as a property of the atoms, cf. vol. i p. 245 n. 1.

¹⁵ It will be seen that from this point of view I adopt exactly the opposite point of view to that of Eva Sachs, *Die fünf platonischen Körper* (Berlin, 1917) 212ff., who seeks to prove from Plato's theory of weight that the elemental triangles were conceived of by Plato as 'bodies'. Significantly, Sachs refers only to Plato's earlier theory, of weight as defined by number, and appears to have taken no account of the later theory, of weight as defined by resistance. Sachs therefore quite fails to appreciate the innovation in Plato's theory, whereby weight is included among the 'affections of sense', and the *difference* therefore be-

(iv)

My purpose, however, is not to pursue more precisely the nature of the opposition, for Plato or for Democritus, between the originating particles, whether atoms or triangles, and the phenomena we perceive, but for the moment simply to remark that the interpretation I have now put forward of Democritus' theory, however simple and even obvious it may seem, has been arrived at retrospectively, from the study of Plato.

Obviously, it would have been possible to remark upon the seeming anomaly whereby weight is neither one of the *sensibilia* nor yet of the same status as shape or size, as a consequence simply of one's own reflection upon the internal coherence and consistency of Democritus' system. But in practice it is Plato's extension of Democritus' scheme which most obviously serves to highlight the apparent discrepancy in the status of weight in the earlier theory, and which serves to alert the historian to the feature which is only implicit in Democritus' theory: the isolation of heavy and light from the opposites that had traditionally been associated with them.¹⁶

The relative simplicity of this judgment should not be allowed to obscure its methodological significance.

From an historical point of view Democritus' system is not fully understood if we take as our ideal the repetition of what Democritus himself would have thought or said. Equally, we do not gain an exhaustive understanding of Democritus' system by attempting to place it within the context of earlier ideas. And yet any direct criticism of Democritus' theory, from our own standards of logic or consistency, would be liable either to proliferate arbitrarily, or to issue in generalities that would have little relevance to the detail of Democritus' theory.

But criticism of Democritus taking account of his more immediate successors avoids this irrelevancy while at the same time releasing the historian of ideas from the restriction of treating ideas as though they were events determined solely, if at all, by their past, and with no special relation to any future event.

For Plato's inclusion of weight among the *pathemata*, although it cannot be treated as in any sense a part of Democritus' theory, is nonetheless so

tween Plato's theory and that of Democritus (see esp. pp. 228-9). The lop-sidedness of Sachs' analysis is rightly criticised by Cherniss, *ACPl* 139 n. 85.

¹⁶ I was of course unable to resist anticipating this point briefly in my first volume, both in commenting on the *De sensibus*, where Theophrastus raises more or less this point in his comparison of Democritus and Plato (*De sens.* 60-4, 68, 71; cf. vol. i pp. 256-8), and in order to note the inevitable anachronism, whereby some historians attribute to Democritus the innovation which we (now) see belongs to Plato (Hamelin, Boricevskij, Hahm; cf. vol. i p. 359 n. 1).

directly relevant to Democritus' theory (even if only as an explanation of what Democritus has *not* said) that fairly plainly Democritus' theory cannot be understood, historically, without it.¹⁷

§ 3. HEAVY AND LIGHT AS 'AFFECTIONS OF SENSE'

Plato's attempt to enlist heavy and light, no less than hot and cold or sweet and sour, among what Theophrastus will call the 'affections of sense' provides us with the initial context for an interpretation of Plato's theory in the sense I have outlined: an interpretation which will avoid the irrelevancies of attempting to compare Plato's theory with wholly modern concepts of 'mass' and 'gravitation', but which will also enable us to move beyond the mere re-statement of Plato's successive allusions to weight throughout the text of the *Timaeus*.

(i)

Thus Plato's innovation, in attempting to include heavy and light no less than hot and cold or sweet and sour among the 'affections of sense',

¹⁷ In this section, I have stated only as 'probable' (p. 285 above) that Plato knew of Democritus and was influenced by him. At the beginning of the century, a great deal of interest was focussed on the supposedly determinative influence of Democritus on the details and the structure of the *Timaeus*, stimulated particularly by Ingeborg Hammer Jensen, 'Demokrit und Platon', *AGPh* n. F. 16 (1910) 92-105 and 211-29: for further references see Wilpert, 'Die Elementenlehre des Platon und Demokrit', *Festschrift für Aloys Wenzl* (München-Pasing, 1950) 49-66, esp. 50 n. 11.

Although it is possible to suggest many points of detail where the ideas of the *Timaeus* appear to coincide with what we know of the atomic philosophy, it is not, I think, really an answerable question, whether the whole of the central portion of the *Timaeus* is intended as a concession to the atomic philosophy, as representing a mechanistic explanation of the universe, flanked by the theistic and teleological expositions of the first and the third parts of the *Timaeus*. This was the thesis on which the debate largely centred, but the question of 'influence' on this level of generality seems to me overshadowed by the difficulty of knowing what other form Plato's ideas could have been cast in, unless we are to advance to wholly different notions of causality whereby the detailed exposition of the material functioning of the universe is replaced by a more purely philosophical notion of the pervasiveness of psychic activity, as for example in the philosophy of Plotinus.

My comparison of Plato and Democritus is not intended therefore to represent the influence of Democritus as imposing a mechanistic stratum upon the more purely teleological notions that had been intimated in the *Phaedo* (which very generally is the thesis of Hammer Jensen and of Wilpert), but only to suggest a coincidence between the theories of Plato and of Democritus, whereby the objects of sense are regarded not as intrinsic properties of the material world, but as springing from the conjunction of the faculty of sense with features of the structure of the material world (the shapes and sizes of atoms, and of Plato's primary particles) which are not themselves directly perceptible. This is, I think, in fact the broadest point on which it is possible plausibly to claim 'influence' of Democritus on Plato. This is not of course to deny that other variously 'subjectivist' theories of sensation were known to Plato (notably Protagoras); it is the combination of this general idea with a physical theory based on the properties of particles which are individually below the threshold of perception which makes it difficult to avoid the conclusion that, on this point, Plato was indebted to the ideas of Democritus.

goes some way, I would suggest, towards explaining the extreme elaboration of Plato's account of heavy and light among the *pathemata*.

The idea that differences of colour, temperature and flavour are not intrinsic properties or powers of the objects we perceive, but arise only from the conjunction between perceived object and percipient, had already been explored by Democritus, whose theories are recorded for us by Theophrastus in the *De sensibus*. The same idea is taken up by Plato himself in the *Theaetetus*.¹⁸

The arguments employed in the *Theaetetus* and recorded in the *De sensibus* turn on the seeming inconsistency of our sensible perceptions. The wine which tastes sweet to Socrates when he is well, tastes bitter when he is ill. Therefore the wine is not in itself sweet or sour; it appears to be so, only in conjunction with a sensible percipient.¹⁹

Now it is true that these arguments do not recur, for differences of taste or colour or temperature, in the *Timaeus*. Plato makes no attempt to show that honey which is sweet, or that *opos* which is sour, may sometimes produce the 'opposite' effect.²⁰

Nonetheless, it seems clear that the *Timaeus* takes for granted the conclusion of the arguments employed in the *Theaetetus* and recorded in the *De sensibus*: for Plato as for Democritus, the sensations we have of hot and cold, or sweet and sour, arise from the action upon our bodies of particles—atoms or triangles—which are not in themselves characterised by these 'qualities'.²¹

And hence the particular interest attaching to Plato's later analysis of heavy and light in the *Timaeus*.²² For here Plato not only seems to take for granted the same conclusion ('heavy' and 'light', no less than 'hot' and 'cold' or 'sweet' and 'sour', are included among the *pathemata*); he also provides what would appear to be an argument for it.

It seems to me that this is very probably a consequence of Plato's innovation. Plato can take for granted, in the case of hot and cold or sweet and sour, that such properties arise only from the conjunction of perceived object and percipient. But Plato cannot take for granted in the same way—his audience will not be ready to let pass without question—that the same principle should apply to the opposition of heavy and light.

¹⁸ *De sens.* 63-4 *et alibi* (cf. DK 68A135). *Theaetetus* 151Eff.: esp. 152B-C (temperature), 154A-B (colour), 159B-E (flavours). The context of the three examples of course differs considerably.

¹⁹ Cf. *Theat.* 159B-E.

²⁰ Honey, *Tim.* 60A8-B3; cf. 66B7-C7; see pp. 116-17 above. *Opos*, *Tim.* 60B3-5; cf. 66A2-B7; see pp. 117-22 above.

²¹ For hot and cold, see ch. VI § 3, pp. 113-15 above.

²² *Tim.* 62C3-63E8, translated pp. 41-4 above.

For these two properties, Plato's innovation must be supported by argument; and hence, in part, the extreme elaboration of Plato's account of heavy and light among the *pathemata*.

(ii)

But where is Plato's argument that 'heavy' and 'light', no less than 'hot' and 'cold' or 'sweet' and 'sour', are to be treated as 'affections of sense'?

I return to what I called earlier the 'alignment of opposites'. Plato tells us that what is 'light' or 'heavy', 'up' or 'down', in one place is the opposite of what is 'light' or 'heavy', 'up' or 'down', in the opposite place.²³

This formula is strikingly reminiscent of precisely those arguments that had traditionally been employed to demonstrate the relativity of the objects of sense.

Thus wine which seems sweet to Socrates when he is well, seems sour to Socrates when he is ill. Therefore the same thing, wine, gives rise to opposite perceptions, with the consequence that the wine cannot be reckoned as in itself 'sweet' or 'sour'. It will appear to be so, only in conjunction with a sensible percipient.²⁴

Similarly, the perception of 'heavy' or 'light' at the circumference, Plato tells us, is 'opposite' to the perception of 'heavy' or 'light' at the centre. The implication of this formula, or so I would suggest, is again that what we perceive is not therefore in itself 'heavy' or 'light'; it appears to be so, only to an observer in a particular state, or in a particular place.

The sequence of thought would be similar in the two cases.

1. Thus wine is not exclusively sweet or sour: for it will seem sweet to Socrates well, and sour to Socrates ill.

2. Plato concludes therefore, in the *Theaetetus*, that 'sweet' and 'sour' arise solely from the conjunction between perceived object and percipient.

There is the equivalent implication, or so I would suggest, in the *Timaeus*.

1. The designation of 'heavy' does not apply exclusively to the measurement of a larger quantity of earth at the centre, for the same name would apply to the 'opposite' calculation: the measurement of a larger quantity of fire at the circumference.

²³ *Tim.* 63D6-E3; cf. ch. II § 2, pp. 35-9 above.

²⁴ Cf. *Theaet.* 159B-E.

2. Therefore, fire and earth are not in themselves heavy or light; they will appear to be so, only to an observer in a particular state, or in a particular place.

In both cases, I would suggest, the paradoxical inconsistency attaching to our perceptions is intended to support the theory that the various characters we perceive are not properties or powers intrinsic to the objects of our perception, but arise solely from the conjunction between perceived object and percipient.

(iii)

But the argument implied in the *Timaeus* and the arguments of the *Theaetetus* or the *De sensibus*, though similar, are not the same.

For in the *Timaeus* we are not told, as we are in the *Theaetetus*, that opposite names attach to the perception of a single object; we are told, conversely, that the same name attaches to perceptions which Plato tells us are 'opposed'.

Thus Plato does not say, in the *Timaeus*, that the 'same' thing will appear both 'heavy' and 'light', in the way that, in the *Theaetetus*, the same thing (wine) will appear both 'sweet' and 'sour'. Instead, in the *Timaeus*, we have the converse of this paradox: namely that 'opposite' perceptions will be called the 'same'.

For what Plato states, in the *Timaeus*, is that what is 'heavy' or 'light', 'up' or 'down', in one place is the *opposite* of what is 'heavy' or 'light', 'up' or 'down', in the opposite place.

On the interpretation I have given of Plato's theory, this will mean that a larger quantity of fire, which is called 'heavy' at the circumference, will be the 'opposite' of a larger quantity of earth, which is called 'heavy' at the centre.

But Plato does not go on from this to say that the *same* thing will appear 'opposite'. For on the interpretation I have given of his theory, Plato does not say that the larger quantity of fire which is 'heavy' at the circumference will be 'light' at the centre.

(iv)

Not only does Plato not employ, for heavy and light in the *Timaeus*, the argument employed in the *Theaetetus* or recorded in the *De sensibus* as attaching to differences of flavour or colour; it would have been impossible for him to do so, without abandoning the correlation, established in Plato's earlier definition, between weight and size or number.²⁵

²⁵ *Tim.* 55D7ff. See ch. V § 1, pp. 79-83 above.

For if Plato had employed the argument of the *Theaetetus* or of the *De sensibus*, and if he had therefore concluded that the larger quantity of fire, for example, was 'heavy' at the circumference but 'light' at the centre, then he would have abandoned the principle, established in his earlier definition, whereby the body with the least number of like parts is lightest.

For if the larger quantity of fire is to be heavier at the circumference, but lighter at the centre, then it will no longer be true that 'heavy' and 'light' are coordinated with the presence of respectively a larger and a smaller number of triangles, which had appeared to be the principle established in Plato's initial explanation of heavy and light in terms of the number of triangles.

Clearly, therefore, the discrepancy between the form of paradox in the *Theaetetus* or the *De sensibus* and the—superficially similar—paradoxical formulation of the alignment of opposites in the *Timaeus* is not accidental to Plato's purpose. But what precisely explains the seeming similarity and yet the radical discrepancy?

(v)

The answer to this question will be clearer, if we extract one further feature from the argument of the *Theaetetus*.

I claimed earlier that Plato's audience would not have been prepared to let pass without question the inclusion of heavy and light among the 'affections of sense'.²⁶

But, at least at first sight, this claim would appear to be invalidated by the argument of the *Theaetetus*. For in that dialogue 'heavy' and 'light' do appear to be included, without any eyebrows being raised, as one example among many of the relativity of our sensible perceptions.²⁷

But 'heavy' and 'light' appear in the *Theaetetus*, I would suggest, not as directly analogous to the examples of sweet and sour, or hot and cold, but rather as analogous to the examples of large and small, or many and few.

In the *Theaetetus*, six dice are more than four and less than twelve.²⁸ Socrates is taller than Theaetetus now, but he will be shorter than Theaetetus next year.²⁹

If we follow these two examples, then a certain quantity of fire will be larger, and so heavier, than some smaller quantity; but smaller and so lighter, than some larger quantity.

²⁶ Cf. p. 290 above.

²⁷ *Theaet.* 152D5, 178B4-5, 189D1-2. Again, the context of each allusion differs considerably.

²⁸ *Theaet.* 154B-C.

²⁹ *Theaet.* 155B-C.

This weaker form of paradox does not breach the principle whereby 'heavy' and 'light' are correlated with respectively a larger and a smaller number of triangles. For there will be no occasion (at least, Plato does not here try to introduce any occasion), when the same number of dice will appear both larger and smaller than any one other number; nor any occasion when Socrates will appear both taller and shorter than Theaetetus at the same time; nor therefore (on this analogy) is there any implication that the same body would appear both heavier and lighter than any one other single body.

According to this weaker form of paradox, the larger quantity of earth or of fire would be invariably heavier, as would seem to be required by Plato's initial definition of weight, in the *Timaeus*, in terms of size or number.

(vi)

The similarity and the difference between the two forms of paradox affects the relation of either paradox to the furtherance of Plato's argument in the *Theaetetus*.

The argument which had traditionally been used to suggest that sensible oppositions arise only from the conjunction of perceived object and percipient had turned on the supposed inconsistency of our perceptions: the same object gives rise to perceptions which are opposed.

Thus wine will appear both 'sweet' and 'sour' to the same percipient at different times, and in a different state. Similarly, a number, or a numbered object, will be 'more' than some smaller number, and 'less' than some larger number.

In both cases, therefore, we can conclude that the object does not possess in itself (or, as Plato would say, 'by nature') the property in question: wine is not in itself 'sweet' or 'sour'; six is not in itself 'large' or 'small'.

But the further implication of the paradox is different, for the comparison of quality and for the comparison of quantity.

Wine will appear 'sweet' or 'sour' because the percipient himself changes. But this is not (or not so obviously) the case with 'large' and 'small'. Six is 'larger' in relation to one number; 'smaller', in relation to another. The terms of the comparison change; but there has been no change in the state of the percipient, or at least no change which is at all obviously comparable to the 'change' between Socrates well and Socrates ill.

(vii)

This difference, in the *Theaetetus*, between the paradox of quality and the paradox of quantity, clarifies, I would suggest, the problem which

Plato has to face, in the *Timaeus*, in his attempt to include heavy and light, no less than hot and cold, or sweet and sour, among the 'affections of sense'.

Plato's earlier definition of weight in the *Timaeus* had attached the difference of 'heavy' and 'light' to a difference of quantity or number: the body with 'the smallest number of like parts' is lightest (cf. 56B1-2).

This correlation of weight and quantity would yield the paradox associated with a difference of number in the *Theaetetus*: a body which is 'lighter' than one body will be 'heavier' than some other body.

But the comparison of quantity will not allow the conclusion whereby the same body can be both 'heavier' and 'lighter' than some other single body; nor therefore will the comparison of quantity yield the paradox which, in the *Theaetetus* as in the *De sensibus*, is associated with various qualitative oppositions, and which in the *Theaetetus* leads directly to the conclusion whereby the seeming inconsistency of our sensible perceptions is explained by a change in the condition of the percipient.

And hence the interest and the complexity of Plato's analysis in the *Timaeus*.

In the *Timaeus*, Plato claims for 'heavy' and 'light' the same status that he has claimed for 'hot' and 'cold' or for 'sweet' and 'sour', at least in so far as differences of weight, no less than differences of temperature and taste, are included in Plato's analysis of the *pathemata*. But the paradox which Plato introduces to support this innovatory claim is significantly different from the form of paradox which is associated with differences of temperature and of taste, in the *Theaetetus* or in the *De sensibus*.

This difference, I would suggest, has arisen because Plato has already adopted, in the earlier passage of the *Timaeus*, a conception of weight as tied to quantity.

Thus in the *Timaeus* Plato provides a paradoxical formulation which suggests to the reader the conclusion adopted for hot and cold or for sweet and sour in the *Theaetetus* as in the *De sensibus*: namely that heavy and light are not intrinsic properties or powers of the objects we perceive. But the paradoxical formulation of the alignment of opposites in the *Timaeus* is significantly different from the form of paradox employed for hot and cold or for sweet and sour, in the *Theaetetus* and in the *De sensibus*, because the form of paradox attaching in those two treatises to qualitative differences, of taste or of temperature, would have belied Plato's own earlier definition, in the *Timaeus*, of heavy and light in terms of quantity.³⁰

³⁰ I have here kept to the most cursory possible comparison between the paradoxical formulation of the 'alignment of opposites' in the *Timaeus* and the various forms of paradox in the *Theaetetus*, and I have ignored altogether Plato's use of similar forms of paradox in other dialogues. I return to the subject in more detail in Note 11, pp. 410-29

(viii)

Quite how Plato has been able to construct the paradoxical formulation of the alignment of opposites in the *Timaeus*, I shall explore in my next section. For the moment, I pause to note one obvious change in perspective and one obvious change in method.

So far, my answer to the supposed inconsistency attaching to Plato's 'two' theories of weight, as defined by number and as defined among the *pathemata*, has been to emphasise—as Plato himself, I believe, wished to emphasise—the close analogy which exists, in the text of the *Timaeus*, between the 'two' theories of heavy and light and the 'two' theories of hot and cold, or sweet and sour, or hard and soft.

In all these cases, Plato's intention, I hope I have shown, has been to explain how the different sizes and shapes of the elemental particles give rise to our various sensations, and how the names of 'heavy', 'hard', 'cold' etc., which we attach to those sensations, are then also applied to the agents which rouse those sensations in us.³¹

But now my intention is to explore the *difference* in Plato's theory between the oppositions of temperature or flavour and the opposition of heavy and light.

This shift in perspective has arisen initially from comparison with Democritus. For from this point of view the comparison of Democritus with Plato works in opposite directions at once. It is, I first suggested, our knowledge of Plato which most easily makes us aware of the discrepancy in Democritus' theory, whereby 'heavy' and 'light', unlike 'hot' and 'cold' or 'sweet' and 'sour', are not included among the 'affections of

below; but a thorough study of the paradox of relativity in Plato is obviously beyond the scope of my present study.

The principal distinctions are that (1) for the paradox of taste or temperature, the condition of the percipient changes; (2) for heavy and light, the position of the observer changes; (3) for large and small or for many and few, there is a change in the terms of comparison. But the argument implied in the *Timaeus* is more complex than the account I have given of it so far, if only because in the calculation of direction, in the first part of Plato's analysis (62C3-63A6), a change in the position of the observer does lead to the full form of paradox associated with a difference of taste or temperature in the *Theaetetus* and the *De sensibus*: for the cosmic traveller, the same thing, the same part of the earth's surface, does appear in turn both 'up' and 'down' (63A2-4; cf. pp. 17ff. above). It is true, there is not the same analysis of direction in the second part of Plato's passage, if only because we do not share the experience of the observer at the circumference (63A6ff.; see esp. pp. 30ff. above); nonetheless, one may suspect that the existence of the full form of paradox in the earlier part of Plato's analysis gives further encouragement to Plato's reader to see in the paradoxical formulation of the alignment of opposites (63D6-E3) the conclusion attaching to the paradox of taste or temperature in the *Theaetetus* or the *De sensibus*. On this point, see further Note 11, pp. 411ff.

³¹ See esp. ch. VIII § 3, pp. 153-7 above.

sense'.³² At the same time, the knowledge we have of Democritus rounds on our interpretation of the *Timaeus*. For it is this same historical perspective which suggests to us the problem to which this part of the *Timaeus* is intended, tacitly, as a solution.

There is then a further shift in perspective. Comparison with Democritus, coupled with comparison with Plato's own arguments in the *Theaetetus*, suggests to us, not only the problem to which Plato's theory of heavy and light in the *Timaeus* may have been intended as a solution, but no less the difficulty which Plato faced in realising this intention.

Thus in his earlier definition Plato has adopted a conception of weight which is the same as that of Democritus, in so far as in both cases the difference of heavy and light is attached to a quantitative criterion: the size of atoms, the number of triangles. And yet Plato has apparently also decided to extend Democritus' theory, so as to have 'heavy' and 'light', no less than 'hot' and 'cold' or 'sweet' and 'sour', arising from the conjunction of perceived object and percipient. The difficulty therefore which Plato faces in his later definition lies in accommodating his earlier quantitative definition of weight to a qualitative opposition, as he is required to do, in so far as his explanation of the opposition of weight is presented as all of a piece with his explanation of the oppositions of temperature or of taste.

Altogether, therefore, comparison of Plato and Democritus illumines the present as well as the past. The comparison enables us to look back to uncover the discrepancy in Democritus' own theory. The same comparison enables us to disengage what is probably the intended innovation in Plato's conception, and at the same time the difficulty which bars the way to Plato's realisation of his intention.

(ix)

This change in perspective carries with it one obvious change in method.

Plato, unlike Aristotle, only rarely presents to us the problems he has taken over from his predecessors, and to which his theories are intended as the solution. The problem of weight is not one of the rare exceptions; in this case, therefore, the 'problem' to which Plato's theory is intended as the 'solution' can be known only indirectly, from a comparison of Plato's theory with that of Democritus.

The 'interpretation' which I now offer of Plato's theory will therefore obviously not be susceptible of the same degree of proof as the 'reconstruction' which so far I have attempted to provide.

³² See the preceding section of this chapter, pp. 284-9 above.

As I noted in my first chapter, the extraordinary elaboration of thought and style in the *Timaeus* has done much to conceal Plato's intention from the modern reader, encumbered as he is with preoccupations and presuppositions derived from Aristotle and from later philosophy, and often wholly alien to the thought of the *Timaeus*.³³ Nonetheless Plato has himself written into the text of the *Timaeus*, or so I believe, the theory of heavy and light which I have thought to reconstruct so far in the course of this essay. Therefore, however deviously and indirectly we may think Plato has realised this intention, nonetheless the means of uncovering his meaning are in principle simple: close attention to the details of the text; constant awareness of the potentially disruptive effect of our own ideas and assumptions.

But the 'interpretation' which I now offer of Plato's theory aims at uncovering a meaning which at best can be only implicit in Plato's writing, and which can be known to us therefore only indirectly. For Plato has not set out, in any overt fashion, to present his theory as an 'answer' to Democritus, even though we may reasonably hope to find that this covert, or at least unacknowledged, intention has in fact affected the way in which Plato has cast his theory.

Still less has Plato employed the distinction of 'quantity' and 'quality', to explain the difficulty which he faces in realising his intention.

On both points, 'interpretation' relies therefore on materials extraneous to the text of the *Timaeus*: comparison with the theory of Democritus, comparison with the different forms of paradox which Plato has himself employed in the *Theaetetus*.

My aim therefore is still to uncover the 'meaning' of Plato's text: but in a way which is now heavily dependent on the accidents of time and place. For if the *Theaetetus* had been lost, if Democritus' theory had not been recorded, even indirectly, by Aristotle, by Theophrastus and by Simplicius, then obviously 'interpretation' of this kind would have been virtually impossible, even though the text of the *Timaeus* might still have survived in its entirety.

(x)

And yet 'interpretation', even when taken so far, is different in kind from any attempt to establish the truth or falsity of Plato's theory, by reference to our own theories of heavy and light, or even by reference to what might qualify as our own standards of 'scientific' or 'rational' argument.³⁴

³³ Pp. 8-9 above; cf. vol. i pp. xv-xvi.

³⁴ For the assumption that the historian of philosophy should try to uncover the 'scientific' value of Plato's arguments, see for example Vlastos, *Plato's universe* 79ff.

This difference seems to me of crucial importance.

An historical enquiry, of the kind I have suggested, is obviously integral, or so it seems to me, to any attempt to understand, with any kind of completeness, the ideas that are to be found in the text of the *Timaeus*.

By contrast, the attempt to deal with ancient ideas non-historically, to try to meet an ancient philosopher so to speak eyeball to eyeball, on a purely philosophical level, wholly divorced from the accidents of time and place, is I believe doomed to failure, except as some kind of mental exercise, only very indirectly related to the study of ancient texts.

And yet the study of ancient philosophy, divorced from any sense of history, is not only the frequent practice of writers on ancient philosophy; it is sometimes even their professed ambition.³⁵

§ 4. QUANTITY AND MOVEMENT

(i)

The paradoxical formulation of the 'alignment of opposites' (63D6-E3) turns on the presence of two observers: ourselves at the centre, and a second, imaginary observer at the circumference.

The existence of intelligent creatures—human or otherwise—in various far-flung outposts of the universe is a recurrent feature of Plato's writing, and the comparison of their experience with our own is a device that Plato employs in some of his most striking and well-known passages.

To take only one example: in the *Phaedo*, our life in the lower air at the edge of the sea, with only occasional glimpses, if at all, of the upper world, is compared both with creatures who live at the bottom of the ocean, with only occasional glimpses of our air, and with beings superior to ourselves who inhabit the aether, and whose oceans are made of air.³⁶

But these and other kindred passages are only superficially similar to the observer imagined weighing quantities of fire at the circumference.

³⁵ Most recently and most blatantly, Jonathan Barnes, who writes in his introduction to *The Presocratic philosophers* (London, 1979) vol. i p. x that: 'Philosophy lives a supracelestial life, beyond the confines of space and time.' I wish I could believe that this was meant to be humorous.

'History', Barnes tells us (*ibid.*), provides mere occasional entertainment. This approach, not suprisingly, leads Barnes hopelessly astray; for only one example, see the chaotic account which Barnes gives of Parmenides' concept of time, vol. i pp. 190-4, criticised in my 'Temps et intemporalité chez Parménide', *Les études philosophiques: le Temps* (1980) 257-72, esp. p. 270 n. 33. In general, Barnes and his playmates seem wholly unaware of the dangers of conceptual anachronism latent in the approach they have adopted for the study of ancient texts. See further my remarks in 'Aristote: quantité et contrariété, une critique de l'école d'Oxford', *Concepts et catégories dans la pensée antique* (Paris, 1980) 89-165, esp. p. 90 n. 2.

³⁶ *Phaedo* 108Dff.

For in the *Timaeus* there is no indication that the experiences of the observer at the circumference are either inferior or superior to our own, which is a distinguishing characteristic of Plato's descriptions in the *Phaedo* and elsewhere.

On the contrary, Plato's instruction in the *Timaeus* is that we have to catch ourselves out doing on earth '*the very same thing*' that the observer has been described as doing at the circumference (cf. 63C5-6).

(ii)

Now this of course is exactly the condition needed for the establishment of heavy and light as 'affections of sense'.

The point of the comparison between Socrates well and Socrates ill, or between Theaetetus and his friends in the perception of colour, is precisely that the one set of perceptions is directly comparable to, and is no less valid, than the other. The perception of wine as sweet is in no way superior to the perception of wine as sour: for even if one perception is more common than the other, the conclusion of the argument is that the wine, in itself, is no more sweet than sour. The one property is as much an 'affection of sense' as is the other.³⁷

Comparison with the *Phaedo* and comparison with the *Theaetetus* therefore combine to highlight an ambiguity in the rôle of the second observer. The introduction of the second observer in the *Timaeus* is not intended to show up the limitation of human experience by analogy with a level of experience superior, or inferior, to our own. And yet, from a merely practical point of view, the experience of the second observer is not something that we can hope to share.

(iii)

What then, more precisely, is the function of the second observer?

According to my earlier analysis, the 'opposition' between the calculations of Plato's imaginary observer at the circumference of the universe and the calculations which we make at the centre of the universe is intended to bring home to us the error in our habitual ways of thinking. We have 'grown accustomed' to thinking that 'up' and 'down', 'heavy' and 'light', have a single and exclusive reference. Plato's description of the second observer brings home to us that, on the contrary, our habitual calculations of direction and weight are related exclusively to the measurement of earth at the centre; and that a parallel and 'opposite' set

³⁷ *Theaet.* 151E ff.; cf. pp. 290 ff. above.

of calculations would be no less appropriate to the measurement of fire at the circumference.³⁸

In the preceding section of this chapter, I sought to enlarge the context of this argument: the perceptions of the second observer are designed to undercut the exclusiveness, and thereby also the seeming objectivity, attaching to the perceptions of a single observer.³⁹ The implication of Plato's argument will be that our perception of earth as 'heavy' is not the recognition of some property or power intrinsic and peculiar to earth, since the larger quantity of a different element—fire—would appear 'heavy' to an observer situated elsewhere in the universe.

The further implication, if the argument of my preceding section is correct, will be that the perception of 'heavy' and 'light' is therefore related to the position of the observer, in the same way that the perception of 'hot' and 'cold', or of 'sweet' and 'sour', is determined by the condition of the percipient.

(iv)

But what is it, in the argument of the *Timaeus*, that distinguishes, and indeed 'opposes', the perceptions of the two observers? How is it that Plato is able to claim, as he does, that what is 'up' or 'down', 'heavy' or 'light', at the centre is the 'opposite' of what is 'up' or 'down', 'heavy' or 'light', at the circumference (cf. 62D6-E3)?

For there is no 'opposition' in the measurement of quantity. Both observers agree that the portion of earth or of fire with the larger number of triangles is heavy, and that the portion with the smaller number of triangles is light.

It is true that, for these two elements, the triangles are different in kind (half-squares for earth; half-equilaterals for fire).⁴⁰ But this difference hardly affects the principle of the theory outlined in Plato's analysis of the *pathemata*. If, instead of spadefuls of earth, we measured bucketfuls of water, it would still be true that, for the measurement both of fire and of water, the quantity with the larger number of triangles would be heavier.

How then is Plato able to conclude, as he has done in constructing the paradoxical formulation of the alignment of opposites, that 'what is heavy' at the centre is the *opposite* of 'what is heavy' at the circumference (cf. 63D6-E3)?

³⁸ *Tim.* 63A6ff.; see esp. pp. 28ff. above. The correction of our 'habitual' vocabulary is common to the *Timaeus* (cf. εἰθίσμεθα, 63A7) and to the *Theaetetus* (cf. ὑπὸ συνηθείας, 157B2), with the difference taken account of in Note 8, pp. 380ff. below.

³⁹ Cf. pp. 291-2 above.

⁴⁰ See p. 80 above.

(v)

The 'opposition' between the perceptions of the observer at the centre and the perceptions of the observer at the circumference fairly clearly turns, not on any difference in quantity, but on the difference in direction of movement.

Thus earlier I suggested simply that Plato introduces different directions of movement into his later argument, in order to make the difference of quantity immediately apparent to the organs of sense.⁴¹

What we measure, when we compare different quantities of earth at the centre, or different quantities of fire at the circumference, is not only the difference in quantity or number between the triangles, but also the difference in the direction of their movement. The larger quantity of earth moves towards the main body of earth at the centre. The larger quantity of fire moves towards the main body of fire, accumulated at the circumference. The *pathemata* of weight arise either when we attempt to remove a larger or a smaller quantity of earth or of fire away from its parent body, or possibly when we seek to hold back a larger or smaller quantity of either element from returning to its like.

But the comparison of movement, I would now suggest, has another, and no less specific, purpose, in so far as it provides the opposition in the paradoxical formulation, whereby what is heavy or light, up or down, in the one place, is the 'opposite' of what is heavy or light, up or down, in the opposite place.

For since Plato has established that centre and circumference are by nature 'opposed', he is able to conclude that the perception by which the larger quantity of earth, in moving towards the centre, is heavy, is 'opposed' to the perception by which a larger quantity of fire is heavy, in moving towards the circumference.⁴²

(vi)

From this point of view, the comparison of movement, and the introduction of a second observer, has resolved—in so far as, for Plato, it can be resolved—the problem of the discrepancy between the two forms of paradox present in the *Theaetetus*.

I have already noted that it would be impossible for Plato, in the *Timaeus*, to represent the same quantity of triangles, say a larger quantity, as at different times, or for different observers, both heavy and light, in the same way, and for the same reason, that in the *Theaetetus* it would

⁴¹ See esp. pp. 153ff. above.

⁴² For a more detailed defence of this point, see further Note 11, pp. 424ff. below.

be impossible to represent four dice as both 'more' and 'less' in relation to any one other number.⁴³

In so far as heavy and light are determined by the presence of a larger or a smaller number of triangles, then the same quantity can appear both heavy and light, if the terms of the comparison are changed (so that what had been the larger quantity is now the smaller quantity in relation to some new grouping of triangles); but there is no way, or no obvious way, in which, within the same comparison, the same object could be counted as both 'larger' and 'smaller', in the way that the wine will appear both 'sweet' and 'sour', at different times or to a different observer.

However, by introducing the comparison of movement, Plato arrives, not indeed at the paradox whereby the same thing is given 'opposite' names, but at a form of paradox sufficiently similar to suggest the same conclusion. For in both cases, the same object (wine) or an equivalent object (a larger quantity of triangles, arranged as fire or as earth) gives rise to perceptions which are 'opposed', with the implication I have noted: that the properties we perceive are not therefore intrinsic to the objects of our perception, but arise only from the conjunction of perceived object and percipient.

(vii)

The point will be that Plato has been able to arrive at this conclusion, because he has added to the analysis of weight a comparison which is not at all, or not directly, quantitative: namely the movement of fire and earth in 'opposite' directions, towards the circumference or towards the centre.

Since centre and circumference remain 'opposed', independently of the names we give to them, it results that 'heavy' and 'light', 'up' and 'down', are given an opposite sense (or an opposite reference), independently of the calculation of quantity, which remains the same for the portion of fire which is 'heavy' at the circumference, and for the portion of earth which is 'heavy' at the centre.

By this means, the quantitative opposition which Plato had established for weight among the *gene* is made to enter into a form of paradox similar to that traditionally associated with those qualitative differentiations of taste and of temperature which had already been reduced by Democritus to the status of 'affections of sense'.⁴⁴

⁴³ Pp. 293-7 above.

⁴⁴ The approximation between the two forms of paradox is, of course, necessarily incomplete. Thus in the paradox of the *Theaetetus* the same person (Socrates) is well or ill, and perceives the wine as sweet (if well) and as sour (if ill). By contrast, in the *Timaeus*, both opposite properties (heavy and light) are perceived independently by each of the two

§ 5. THE COMPARISON OF ELEMENTS

But for this 'solution' to his problem Plato has a heavy price to pay.

The introduction of the second observer makes it impossible for Plato to recover, in his analysis of weight among the *pathemata*, the comparison between different elements which had been the principal feature of his account of weight among the *gene*.

Thus in the construction of the geometrical solids fire is the 'lightest' body (*cf.* 56B1). But in the analysis of heavy and light among the *pathemata* (62C3ff.), we know only that the larger and smaller quantities of fire or of earth are respectively 'heavier' and 'lighter'. In this later theory, we have no means, or no obvious means, of telling whether fire is 'lighter' than earth, nor therefore any obvious means of concluding that fire is the 'lightest' element.

This has remained the principal discrepancy in the conciliation of Plato's two theories of weight which it has been the purpose of my essay to establish; but it is only from the present 'interpretative' point of view that we can begin to see at all fully the reason underlying this discrepancy.⁴⁵

(i)

But first it is not so much the answer to the problem, as the problem itself which needs to be clarified.

The interpretation adopted by Martin, and propagated by Taylor and by Cherniss, I have argued falsifies Plato's intention, in so far as it foists onto the text of the *Timaeus* a needless inconsistency, whereby the correlation of weight and quantity, established in Plato's account of weight among the *gene*, can no longer apply to Plato's analysis of weight among the *pathemata*.⁴⁶

But although these authors claim (explicitly or by implication) that Plato's 'two' theories are therefore inconsistent, they nonetheless freely introduce into the later theory the feature which is in fact peculiar to Plato's analysis of weight among the *gene*: namely the comparison of different elements, and the conclusion whereby fire is 'lightest'.⁴⁷

observers (at the centre and at the circumference). The approximation between the two forms of paradox would be complete, only if Plato abandoned altogether the quantitative criterion of weight, as in effect he does in Taylor's interpretation of Plato. On this point, see below Note 11, pp. 416ff.

⁴⁵ *Cf.* p. 156 above.

⁴⁶ For Taylor and Cherniss, see pp. 45ff. and 153ff. above. For Martin, see Note 3, pp. 327ff. below.

⁴⁷ For the contradiction which this point gives rise to in the interpretations of Taylor and Cherniss, see esp. Note 3, pp. 331ff. below.

And from this point of view the objection could be made to my own reconstruction of Plato's theory, that in saving Plato from one inconsistency I have simply lumbered him with another.

Plato no longer, on the reconstruction I have given, suffers from the inconsistency which characterises his theory in other modern interpretations of the *Timaeus*: namely the refusal of the comparisons of 'heavy' and 'light' established in the analysis of the *pathemata* to answer to the quantitative determination of weight established in the analysis of the *gene*. But on my reconstruction Plato's theory is subject to a fresh and hardly less damaging inconsistency: namely that the comparison of different elements established in the analysis of the *gene* cannot be duplicated in the analysis of 'heavy' and 'light' among the *pathemata*.

Is Plato's last state any better than his first? Why rid Plato's theory of one inconsistency, only to introduce another and seemingly no less serious inconsistency, where none had been seen before?

The answer to this question is essential to the type of interpretation that I have thought to offer of Plato's theory.

(ii)

In order to overcome the discrepancy which Cherniss and others have seen in Plato's text, we have only to avoid attributing to Plato more than he has in fact said.

For the discrepancy which there arises in Taylor's or Cherniss' reading of the *Timaeus* arises from the wholly gratuitous assumption that the quantity of earth which is heavier at the centre would be lighter at the circumference. Once we recognise that Plato neither states nor implies such a 'reversal' of the measurement of fire and earth at circumference and centre, then there is no reason to suppose that the analysis of weight among the *pathemata* requires us to abandon the quantitative criterion of weight established in Plato's account of the *gene*.

By contrast, in order to avoid the discrepancy which there remains in Plato's text on the reconstruction that I have adopted of his theory, we should have to adopt just the opposite policy: we should have to *add* to Plato's text. We should have to try to reconstruct, for the analysis of weight among the *pathemata*, the comparison of different elements which in fact appears explicitly only in Plato's account of the *gene*.

It is true that, at first sight, this assumption may seem plausible enough. For ironically, the failure of modern commentators to note the absence, in Plato's analysis of the *pathemata*, of any comparison between different elements is perhaps in some ways a measure of Plato's success.

For the very readiness with which Martin, Taylor, Cherniss and others have been willing to introduce the comparison of different elements into

Plato's account of the *pathemata* does perhaps reflect Plato's intention, in so far as, throughout the *Timaeus*, Plato does like to suggest that the general principles he has established will be susceptible of more detailed application by those who have the time and inclination.⁴⁸

Thus in the case of the *pathemata* of heavy and light, Plato brings home to us, in a striking fashion, how it is that his earlier account of triangles and of movement will provide us with 'sensations' of heavy and light, at least for the measurement, on earth, of earth and of things like earth. The reader is easily led to suppose that the same principles would somehow apply to the measurement of the many objects of our common experience which we already know, from Plato, include a proportion of fire: water, before it has changed into snow and frost; oil and wine and other 'juices'.⁴⁹ And from this we may easily come to think that the same principles should apply directly to the comparison of different elements, and so to the conclusion whereby fire is 'lightest'.

But if in fact we seek to add to Plato's theory in this way, we find that we plunge further and further into concepts that have no obvious foothold in the text of the *Timaeus*, and that cause increasing disruption to the economy of the whole.

(iii)

Thus at first sight it may seem simple enough, to a modern reader, to use the criterion of quantity as a measure of force, in such a way as to be able to compare directly both the parts of a single element, and the parts of different elements, irrespective, in the latter case, of the difference in the direction of their movement.

In either case, the modern student may say, 'force' will depend upon the quantity of individual particles in any body, each seeking to return to its native element. A larger quantity of fire will then be heavier, i.e. more forceful, than a smaller quantity, whether of fire or of earth, in so far as fire in a certain quantity, fire with a larger number of triangles, will move towards its native element with greater force than some other quantity of earth or of fire, which would have fewer triangles and would therefore move towards its parent body with less force (or, conversely, would require less force to drag it away from its parent body, or to keep it from returning thither).

From this it would follow that fire was the 'lightest' of the elements, as Plato says it is in his account of the *gene*, since a single particle of fire will

⁴⁸ See especially the conclusion to Plato's account of metals, 59C5ff.

⁴⁹ Snow and frost, 59D4ff. 'Juices', cf. 60A3.

have fewer triangles and will be lighter therefore than a single particle of any other element, at least of an equivalent grade.

Equally a number of particles of fire will be lighter than the same number of particles of any other element, in an equivalent grade, since again the body with the smallest number of triangles will manifest the least 'force'.⁵⁰

The difference between Plato's 'two' theories would then be simply that in the account of the *gene* we measure a static quantity, whereas in the account of the *pathemata* we take the number of triangles as a measure of force.

And this, it will be said, is in principle little different from the implication that I have already sought to add to Plato's theory, for the comparison between different quantities of earth at the circumference or for the comparison between different quantities of fire at the centre.⁵¹

(iv)

But again it is essential to appreciate the radical difference between my earlier suggestion and the present hypothetical reconstruction of Plato's theory in terms of force.

Earlier, my point was that *if* Plato intends us to extend his theory to include the calculation of fire at the centre and of earth at the circumference, then it is likely to be because he has essentially a single notion of resistance for calculating the weight of an element both in its own place and in the place which is opposite to it: in either case we measure the force exerted by the element, or by ourselves, when we try to drag a body away from its natural place, or when we try to prevent it returning to it.⁵²

This, it seems to me, is the furthest we can properly go in attempting to uncover the meaning latent in Plato's account of resistance.

The provocation for perhaps adding to Plato's theory in this way lies in the final definition, which does seem as though it may possibly be intended to cover the calculation of an element in either place, its 'own' or the place that is opposite to it; while the justification for adopting the particular addition that I have outlined is that the notion of resistance which it employs is so close, in effect, to the notion of resistance which Plato writes of explicitly that it could easily have been taken for granted, we

⁵⁰ For the problem of the different grades of triangle, see above pp. 83ff., and Note 4, pp. 341ff. below.

⁵¹ See pp. 70ff. above.

⁵² For my earlier analysis of the two kinds of resistance, see ch. IV § 3, pp. 70-5 above.

may argue, as the obvious adjunct to an extended interpretation of the final definition.

The *disadvantage* of the explanation I have now outlined for the comparison of different elements, and for the conclusion whereby, even among the *pathemata*, fire would be 'lightest', is that it stresses precisely the *difference* between these two kinds of resistance.

For in making the calculation that I have now outlined we are in effect comparing directly two different kinds, or at least two different manifestations, of resistance: the resistance by which we keep an element from returning to its native body, and the resistance we experience in seeking to drag an element away from its native body.

For the scheme that I have outlined would enable us to compare directly the 'force' with which fire, for example, moves towards the circumference and the 'force' with which earth or water moves towards the centre. But once we attempt to adapt this comparison to Plato's later analysis, of weight as defined by resistance, we shall find ourselves required to compare, at the same time, the 'force' or 'effort' by which we seek to *prevent* fire from *returning* to its like (if we think of the comparison as realised on earth) and the 'force' or 'effort' which we should have to exert in dragging earth or water *away from* its like.

The point of my earlier suggestion was precisely that, for the comparison between different parts of the *same* element, these two kinds of resistance may be sufficiently similar for Plato to have engrossed the one in the other, as it were; and that this may be why Plato has felt no conscious need to extend his theory explicitly to include the measurement of either element in a place 'opposite' to its own.

On the present—hypothetical—proposal, for the comparison of *different* elements, Plato would be required to compare the two kinds of resistance directly. In that case, the spell of loose association, which seems to me the best explanation of Plato's half-silence, would be broken; and I think that it would then have been difficult for Plato to offer the final definition in the forthright way that he does, without concerning himself, more explicitly, with the consequence of his final definition for the measurement of earth at the circumference and of fire at the centre.⁵³

(v)

At the same time it would, I think, have been difficult, on a merely practical level, for Plato to envisage a way in which these two kinds of resistance could have been compared directly.

⁵³ For the same implication in Theophrastus' final criticism of Plato's theory, see above ch. XIV § 2, pp. 276-7.

For the image, or the instrument, by which Plato particularises, and expresses, his notion of resistance is a pair of scales. But a pair of scales can measure only elements which, in travelling towards their parent element, will be moving in the same direction: fire towards the circumference (if the observer is stationed at the circumference), earth towards the centre (for the observer standing on earth).⁵⁴

In order to compare fire and earth *with each other*, we could no longer use a pair of scales, which is the image Plato has specifically in mind. We should, instead, have to imagine ourselves as somehow pulling a lump of earth away from the centre with one hand, and holding onto something fiery, that was pulling in the opposite direction, with the other hand.

Not only is this in itself implausible; it is in any case virtually impossible to reconcile with Plato's final definition, even taken in its extended sense.

For even in the final definition Plato's account of heavy and light is fairly clearly limited to the comparison between different quantities of the same element. A quantity of fire (at the circumference) or of earth (at the centre) will be reckoned as heavy and as moving downwards, if it is returning to its parent element, as contrasted to a quantity of fire or of earth, which will be light and will be reckoned as moving upwards if it is moving away from its parent body.

This whole idea still clearly flows from the use of a pair of scales, where the smaller quantity moves 'upwards' and is 'lighter', only because it is forced to do so by the larger quantity.

(vi)

Not only does the comparison of different elements among the *pathemata* find no obvious foothold in Plato's expression of his theory; not only is it difficult, in practice, to circumvent Plato's reliance on the use of a pair of scales, in the expression of his ideas; the attempted reconstruction of Plato's theory in terms of 'force', so as to allow the comparison of different elements even among the *pathemata*, falls foul of one final, and I believe overwhelming, objection: it would destroy the argument, implied in Plato's exposition of the *pathemata*, for the inclusion of heavy and light among the 'affections of sense'.

For simple, and even elementary, though this reconstruction of Plato's theory may appear, a 'unified' conception of force, of the kind I have outlined, is impossible for Plato, or so I would suggest, because, with this conception, Plato could no longer claim that 'what is heavy' at the centre is the opposite of 'what is heavy' at the circumference.

⁵⁴ The measurement of fire, 63B5-6; of earth, 63C6-8.

For with a unified conception of force the 'opposition' in Plato's formulation would be irrelevant to the calculation of heavy and light, precisely because this new and unified conception of force would apply to the calculation of movement, independently of any difference in direction.

Thus if movement were taken directly as a measure of weight, so that a body with a 'more forceful' movement is 'heavier', then there would no longer be any obvious sense in which the larger quantity of fire which is heavier at the circumference would be the 'opposite' of the larger quantity of earth which is heavier at the centre. For movement towards the centre and movement towards the circumference would be equally an explanation of weight, dependent only on the measure of force inherent in the movement of the larger or the smaller quantity.

But if Plato can no longer claim that what is heavy at the circumference is the opposite of what is heavy at the centre, then he can no longer claim, as implicitly I believe he means to do, that 'heavy' and 'light' are not intrinsic properties or powers attaching to the elements.

For if each triangle, or each group of triangles, is used as a measure of weight, independently of any difference in the direction of its movement, then Plato's theory will in practice be indistinguishable from that of Democritus, in so far as the number of triangles will provide a measure of weight, independently of their relation to a sensible percipient.

(vii)

This is, of course, essentially the form to which Plato's theory has been reduced, in the criticisms made of the theory by Aristotle and by Theophrastus. And this is the form in which Plato presents his own theory, in his explanation of weight among the *gene*.

But Plato's earlier theory, if taken in isolation, as also the criticism of Plato's theory made by Aristotle and by Theophrastus, ignores the association of weight with movement, which is the distinctive feature of Plato's analysis of heavy and light among the *pathemata*, and ignores therefore the whole innovation of Plato's theory, whereby heavy and light are to be included among the 'affections of sense'.

For it is, or so I have argued, the association, in Plato's later theory, of number or quantity with movement which allows Plato to present our perceptions of 'heavy' or 'light' as 'opposed', and which therefore introduces into Plato's theory the implication that what is heavy or light will be so, only in relation to the position of a sensible percipient.

If the 'opposition' in Plato's theory of movement were removed, to be replaced by a unified conception of force, independent of any difference

in the direction of movement, then Plato's later theory, and the whole notion of weight as dependent upon the conjunction of perceived object and percipient, at least in the form in which Plato has chosen to present that idea, would have been made in practice indistinguishable from the purely quantitative conception of weight which underlies both Democritus' theory, and Plato's own earlier analysis of weight among the *gene*.

(viii)

I return therefore to the very simple perspective which I believe has in fact determined the conjunction, in Plato's theory, of quantity and movement.

The addition, in the later theory, of the comparison of movement to Plato's initial comparison of quantity enables the difference of heavy and light to be made immediately apparent to our sensible perception.

The same conjunction of ideas also enables Plato to construct the paradoxical formulation, whereby the perception of what is heavy at the centre is opposed to the perception of what is heavy at the circumference, a paradox which enables Plato to suggest to the reader that 'heavy' and 'light' are dependent upon the co-operation of a percipient no less than are 'hot' and 'cold', or 'sweet' and 'sour'.

But having won so much Plato has to let pass the anomaly that his second definition of weight will no longer provide directly for the measurement of an element in a place 'opposed' to its own (earth at the circumference; fire at the centre), nor at all for the comparison of different elements.

Thus Plato's earlier definition had provided explicitly for the comparison of different elements: fire is the 'lightest' body because it has 'the least number of like parts' (*cf.* 56B1-2). But this same conception cannot be extended to Plato's analysis of weight among the *pathemata*. For Plato has no means, either practically or conceptually, by which we can compare, in terms of heavy and light, the movement of different elements in different directions, without destroying the paradoxical formulation whereby Plato suggests to his readers that 'heavy' and 'light' are no longer, as they had still in part been for Democritus, intrinsic properties or powers, not (fully) reducible to the status of 'affections of sense'.

§ 6. NEW AND OLD IN PLATO'S CONCEPTION OF HEAVY AND LIGHT

(i)

Very briefly, therefore, I return to the distinction that I drew in the final chapter of my essay on Democritus. In the fifth century, or so I

argued, 'weight' was associated both with differences of density and with movement in different directions.⁵⁵

Movement may play a part, or so I argued, in Democritus' conception of weight, in so far as differences of speed are perhaps associated with differences of size and weight in the atoms that clash and collide in the void. But movement 'up' and 'down' is so to speak an extraneous feature in Democritus' conception of weight, in so far as although larger and smaller atoms, or groups of atoms, are distributed respectively to centre and to circumference of the cosmos, this is not the effect solely of their differences in weight, but is a consequence of the action of the *dine*.

From this point of view, Democritus' theory of the weight of the individual atom as covariant with its size, and of the weight of compound bodies as dependent upon the proportion of void, is rather a rationalisation of the alternative association of weight with density.

(ii)

I claimed earlier that for Plato the opposite would be the case.⁵⁶ We can now see in what sense this is so.

Plato's account of weight among the *gene* may fairly obviously be seen as analogous to Democritus' association of weight with size, with the difference only that, for Plato, the size of a particle is reducible to the number of equal elemental triangles from which it is constituted: for Plato, therefore, weight is attached not to size, but to number.

For Plato, as for Democritus, the association of weight with size or number is applied not only to the comparison between the individual polyhedra or atoms, but no less to the comparison between groups or agglomerations of polyhedra or of atoms. Thus the weight of compound bodies, for Plato as for Democritus, will depend in part upon the gaps or 'emptiness' between the elemental particles.

From this point of view, Plato's innovation lies in the attempt, in his later definition, to adapt this quantitative conception of weight to the way in which we 'feel' things to be heavy or light. For the whole cast of Plato's theory is fairly obviously designed to include heavy and light as 'affections of sense', comparable, in this respect, to hot and cold, or to sweet and sour, whereas, for Democritus, the status of heavy and light had been, in this respect, exceptional, and even ambiguous.

The point to appreciate, however, is that Plato achieves this extension of Democritus' theory by appealing to the alternative factor in early conceptions of heavy and light: the association of weight with movement.

⁵⁵ Vol. i pp. 364-83. See esp. Theophr. *De sens.* 59 (*cf.* vol. i p. 371).

⁵⁶ Vol. i pp. 381-3, *cf.* 364-7.

(iii)

Thus Plato had already supposed, in his account of weight among the *gene*, that fire and earth move in opposite directions. But in Plato's earlier account this idea is not directly connected with the notion of heavy and light as determined by quantity, except in so far as Plato's numerical analysis is intended as an answer to the movement of like to like in the 'primitive world'.⁵⁷

In the later passage, however, movement is directly attached to our measurement of weight, in so far as the calculation of weight by resistance is determined both by the quantity of triangles and by the direction of their movement.⁵⁸

Thus although the association of weight with movement had appeared also in the earlier of Plato's two analyses, and had indeed been intended in that passage, or so I suggested earlier, as a rationalisation of the association of weight and movement in Plato's account of the 'primitive world', nonetheless movement in the earlier passage had not been offered as the cause or explanation of weight.

In the later passage, by contrast, the direction of movement, no less than the number of particles, is essential to Plato's explanation of the *pathemata* of heavy and light: our sensation of heaviness is caused by the movement of the larger number of particles towards their parent body.

There are, however, two different ways in which movement is associated with weight in Plato's later theory.

(iv)

In the comparison between different parts of the same element, movement is directly aligned with the calculation of quantity. The larger portion of fire or of earth moves 'downwards', and is 'heavy'; the smaller portion of either element moves 'upwards', and is 'light'.

This association of movement with quantity establishes the unity of the 'two' theories of weight in the *Timaeus*: the analysis of weight among the *gene*, and the analysis of weight among the *pathemata*.

In his analysis of weight among the *gene*, Plato has adopted from Democritus, or so I have suggested, the association of weight with quantity (probably a direct borrowing). In his analysis of weight among the *pathemata*, Plato has adopted the idea of including heavy and light among the 'affections of sense' (an extension of Democritus' theory). This conjunction of ideas requires the difference of 'heavy' and 'light' to be made

⁵⁷ See esp. pp. 157ff. above.

⁵⁸ See esp. pp. 153ff. above.

immediately apparent to the faculty of sense, and yet forbids the use of any direct criterion of weight, other than that of quantity.

The introduction of movement answers nicely to this need. Movement had already been included in the context of Plato's earlier analysis of weight, as part of Plato's description of the structured universe. Movement can therefore be re-introduced into the later theory, in order to make the difference of heavy and light immediately apparent to our faculty of perception, provided only that it does not usurp the definition of weight by quantity.

For if Plato had included in his later theory any conception of weight independent of the criterion of quantity, he would, so to speak, have broken the rules of the problem established by Democritus, whereby the *sensibilia* can be explained solely as the effect upon a percipient of entities which are themselves deprived of the sensible qualities they appear to possess in our perception of them.

Weight, among the *gene*, has been allied, for Plato as for Democritus, to a difference of quantity (size or number). This therefore must remain the only direct criterion for heavy and light when differences of weight are included among the *sensibilia*, even if movement is there added to quantity as a necessary adjunct for the inclusion of heavy and light among the *pathemata*.

(v)

But the difference in direction of movement also serves in Plato's later theory to establish a difference between the elements: fire moves to the circumference, earth to the centre.

This use of movement is more problematical.

In asserting, against the earlier and naïve view, that bodies move towards the centre and towards the circumference 'voluntarily', and in attempting to fabricate, for heavy and light, as for hot and cold or for sweet and sour, the paradox whereby the same object, or an equivalent object, gives rise to perceptions which are 'opposed', Plato has found it necessary to retain, for movement in both directions, towards the centre and towards the circumference, the terminology of heavy and light and of up and down.

This leaves Plato with no conception of 'force' or 'resistance' which would serve to compare, in terms of heavy and light, the movement of more than one element in opposite directions: earth to the centre, fire to the circumference.

The measurement of weight by number is restricted therefore, in Plato's later theory, to a calculation of the difference between portions of

the same element. The distinction between different elements is established by the direction of their movement; but this difference in the direction of movement is not given any independent expression, as a difference of heavy or light.

(vi)

And hence the central paradox in Plato's theory: in adopting movement as an essential feature of his analysis of heavy and light among the *pathemata*, Plato has been brought to a position where the elements can no longer be compared *with one another* as heavy and light.

The 'voluntary' movement of fire to the circumference, no less than of earth to the centre, has established a radical difference between the elements; a difference which Plato makes an essential feature of his innovation in including heavy and light, no less than hot and cold, sweet and sour, among the 'affections of sense'; and yet that distinction is not in itself characterised as a difference of 'heavy' and 'light'.

From this point of view, heavy and light are still determined, as they had been for Democritus, by a difference of quantity (whether size or number).

The movement of the elements, although an essential feature of Plato's explanation of heavy and light as *pathemata*, fails to establish the difference *between* the elements as a difference of weight.

(vii)

The ghost of Aristotle's theory already hovers in the wings: for Aristotle will adopt a theory of weight which, from this point of view, is almost exactly the converse of Plato's view.

For Plato, the difference of quantity is the primary determinant of the difference between heavy and light; while the difference of movement, though essential to our perception of the difference of quantity, does not confer upon the elements any independent characterisation as 'heavy' or 'light'.

For Aristotle, just the converse is true: the difference in quantity is subordinated to the difference of heavy and light, a difference which is now determined primarily by the movement of the elements in opposite directions.

Thus for Aristotle fire which moves to the circumference is light absolutely; earth which moves to the centre is heavy absolutely. For these two elements, the difference in quantity will no longer establish a difference of heavy and light, but only a difference of degree: a larger and a smaller quantity of earth are respectively more heavy and less so; a larger and a smaller quantity of fire are respectively more light and less so.

But if Aristotle, from this point of view, has inverted the relative significance of quantity and of movement in Plato's conception of weight, nonetheless it is Plato who has established the difference in direction of movement as essential to the perception of weight.

(viii)

And hence the impossibility, for the historian of philosophy, of detaching Plato's theory from its position in the development of ideas.

For the existence of 'two' theories of weight in the *Timaeus* is hardly accidental: the 'two' theories correspond to the two criteria of weight which in the *De sensibus* Theophrastus tells us had been present in earlier Greek conceptions of heavy and light.⁵⁹

From the association of weight with density, Democritus had isolated a theory of weight as dependent upon the size of the atoms. Plato takes over this same association in his analysis of weight among the *gene*.

Conversely, in his analysis of weight among the *pathemata*, Plato exploits the alternative criterion, the association of weight with movement, although it is left for Aristotle to give formal recognition to the subordination of quantity to movement.

Plato therefore, as I noted earlier, holds the two ideas in suspension, as it were: the old and the new, the Democritean association of weight and quantity, the Aristotelean association of weight and movement.⁶⁰ The Democritean association of weight and quantity is recognised in the analysis of weight among the *gene*. The Aristotelean association of weight and movement is prefigured in the analysis of the *pathemata*.

The 'two' theories are undoubtedly intended by Plato as complementary features in a single but complex conception of weight. The inconsistency which there remains in the *Timaeus*, despite Plato's intention, is at once a reflection of the duality in early Greek conceptions of heavy and light, and a measure of the development of ideas, from Democritus to Aristotle.

⁵⁹ *De sens.* 59; cf. vol. i p. 371.

⁶⁰ Cf. the Introduction to vol. i, p. xix.

NOTES

‘CENTRE AND CIRCUMFERENCE’ (*TIM.* 62D8-10)

I have simplified my analysis of the precise meaning of the sentence at *Timaeus* 62D8-10 by including only the interpretations of Taylor and Cornford (pp. 10-15 above). In fact, the way in which either scholar arrives at his interpretation is largely determined by earlier controversy over the meaning of the passage.

Plato writes, 62D8-10: ὁ δὲ πέριξ οὔτε δὴ μέσος οὔτ' ἔχων διάφορον αὐτοῦ μέρος ἕτερον θατέρου μᾶλλον πρὸς τὸ μέσον ἢ τι τῶν καταντικρύ.

Martin translated, with more or less the correct sense, although without being scrupulous or accurate enough in his representation of the Greek, *Études* i 169:

‘... et l’espace environnant n’est pas lui-même au milieu et n’a d’aucun côté aucune partie qui soit spécialement dans la direction du milieu, plutôt qu’une partie située du côté opposé.’

Fraccaroli objected to this, *Platone, il ‘Timeo’* 296 n. 2, that μᾶλλον should govern θατέρου, and that πρὸς τὸ μέσον should mean not ‘nella direzione del centro’, but more loosely, ‘in relation to the centre’. The meaning is now that:

‘quello (*sc.* luogo) che è alla periferia evidentemente non è in mezzo, nè ha alcuna parte di sè stesso che sia in rapporto differente di un’altra col mezzo o con checchessia che stia ad essa in opposizione.’

But in escaping from one error Fraccaroli has only fallen into another. His objection does properly highlight the slight freedom in Martin’s translation, that μᾶλλον has to do service both for ‘spécialement’ and for ‘plutôt que’, and the more serious deficiency that in Martin’s translation there is strictly speaking nothing to represent διάφορον. On the other hand, Fraccaroli has succeeded in restoring some sense to διάφορον, only by draining the meaning from μᾶλλον: ‘in rapporto differente ... col mezzo’ translates διάφορον ... πρὸς τὸ μέσον, but with this translation where is the need for μᾶλλον?

The redundancy of μᾶλλον leads Fraccaroli to take ἢ to mean not ‘than’, but ‘or’: ‘o con checchessia che stia ad essa in opposizione’. This had in fact been the traditional translation of ἢ: it is to be found in Friedrich Ast, *Platonis ... opera* v (Lipsiae, 1822) 211, and in Gottfried Stallbaum, *Platonis opera omnia* vii (Gothae et Erfordiae, 1838) 258, and this I take it is the sense obtained by Immanuel Bekker’s ‘et’ *Platonis*

dialogi pars iii vol. 2 (Berolini, 1817) 84, repeated from Ficinus' Latin translation (*editio princeps*, 1484):

‘... neque medium est, neque partem in se habet aliam ab alia differentem, quo ad ipsum medium et omnino quicquid sit e regione locatum.’

Fraccaroli's reasoning is acknowledged by Taylor, who repeats the translation of ἢ as 'or', *Commentary* 437 (*cf.* pp. 10-11 above). But when Cornford then rightly reverts to ἢ meaning 'than' (*Cosmology* 262 and 262 n. 3: see pp. 11-12 above), he retains two errors which betray, directly or indirectly, the influence of Fraccaroli. Cornford leaves πρὸς τὸ μέσον with the neutral sense that Fraccaroli had given it: 'with reference to the centre'. Despite his disclaimer (*Cosmology* 262 n. 3), Cornford appears to attach ἢ not, as Martin had done, to μᾶλλον, but in some way to διάφορον, or perhaps to some kind of composite expression, διάφορον ... μᾶλλον. How else can one explain his translation: 'nor is there any difference, distinguishing one part of it from another with reference to the centre, which does not belong equally to some part on the opposite side'?

As often with the study of classical texts, the sins of the fathers are visited on their children. Succeeding generations of scholars correct first one point and then another in the traditional translation of a text, but none looks to see where the error that he seeks to correct has sprung from, nor does he attempt to look at the text afresh and as a whole, with the unhappy result that ancillary misconceptions which the error had given rise to cling to the text even when the error itself has been uprooted. So it is now with Cornford. He corrects the erroneous translation of ἢ which he has found in Taylor, and which Taylor had taken from Fraccaroli, but his own translation merely exaggerates the awkwardness which Fraccaroli had already experienced in translating the expression which depends upon ἢ. For Cornford's translation would seem to imply, as Plato's text does not, that there could be some difference attaching to one part of the circumference and not to another, but that all will be well provided the difference attaches 'equally' to some part on the opposite side. Here the meaning of ἢ as 'than' and its dependence upon μᾶλλον shades off into the meaning of 'and' or 'or', and dependence upon διάφορον.

A clear understanding of the text requires a more radical re-thinking than any simple substitution of 'than' for 'or'. The proper answer to Fraccaroli, as it seems to me, is that μᾶλλον πρὸς τὸ μέσον is a single phrase, and that διάφορον governs θατέρου: no part is 'different from another' in being 'more towards the centre'. It is then perfectly possible for μᾶλλον to govern ἢ, 'more towards the centre than ...'; which is essentially the sense of the duplication in Martin, 'spécialement dans la direc-

tion du milieu, plutôt que ...'. For where both Fraccaroli and Martin have erred is in isolating one comparison at the expense of the other. Martin highlights the comparison expressed by $\mu\alpha\lambda\lambda\omicron\nu$ and underplays the comparison expressed by $\delta\iota\acute{\alpha}\phi\omicron\rho\omicron\nu$. Fraccaroli does just the reverse: he highlights the comparison expressed in $\delta\iota\acute{\alpha}\phi\omicron\rho\omicron\nu$, and he leaves no independent meaning for $\mu\alpha\lambda\lambda\omicron\nu$. The truth, I have suggested (pp. 12-14 above), is that Plato has two comparisons, of which the second serves to justify the first: no one point on the circumference is different from any other (the first comparison, expressed by $\delta\iota\acute{\alpha}\phi\omicron\rho\omicron\nu$) by being closer to the centre than any of the points which are opposite to it (the second comparison, expressed by $\mu\alpha\lambda\lambda\omicron\nu$).

Once we have distinguished the two comparisons, then there is no longer any force in Fraccaroli's objection that ' $\mu\alpha\lambda\lambda\omicron\nu$ ha il suo complemento di comparazione in $\theta\alpha\tau\acute{\epsilon}\rho\omicron\nu$, e ... perciò male si potrebbe dargliene un altro in $\eta\ \tau\iota\ \tau\omicron\nu\ \kappa\alpha\tau\alpha\nu\tau\iota\kappa\rho\acute{\upsilon}$, ... tanto più che (*sc.* le quali parole) varrebbero a restringere il concetto generale ed esatto di $\theta\alpha\tau\acute{\epsilon}\rho\omicron\nu$ in quello del solo punto opposto, che non si sa perchè di preferenza dovesse essero preso in considerazione'. For the point will be that it is the relation with 'the part opposite' which, so to speak, threatens the uniformity of the circumference, and would lead to the fear that one point on the circumference might be different from *any* other; put more positively and more simply, it is the lack of imbalance between 'opposite' points on the circumference which ensures the uniformity, and the neutrality, of the circumference as a whole. Plato's reasoning will be that no one point on the circumference can be different from any other, since it will not be true of any one point on the circumference that it is closer to the centre than the point, or points, which are opposite to it.

Taken in this way, the words $\eta\ \tau\iota\ \tau\omicron\nu\ \kappa\alpha\tau\alpha\nu\tau\iota\kappa\rho\acute{\upsilon}$ are essential to Plato's reasoning, whereas Fraccaroli had the honesty to admit that on his interpretation they were superfluous: 'le quali parole sarebbero del tutto superflue e ingombranti'; he suggests even: 'e il cancellarle potrebbe essere forse un espediente migliore.' It is sadly characteristic of Taylor's commentary that in following Fraccaroli he fails to note the radical objection that Fraccaroli had rightly brought against his own interpretation. Indeed Taylor's translation only accentuates the difficulty, for whereas Fraccaroli had apparently understood $\tau\omicron\nu\ \kappa\alpha\tau\alpha\nu\tau\iota\kappa\rho\acute{\upsilon}$ as a true plural ('any one of the parts that is opposite to the part first thought of'—which seems to be the meaning intended by 'checchessia che stia ad essa in opposizione'), Taylor appears to take this expression, although a plural, as meaning in fact only the middle. It is perhaps not too much to suppose that he has been misled by Fraccaroli's erroneous transcription of $\tau\tilde{\omega}\ \kappa\alpha\tau\alpha\nu\tau\iota\kappa\rho\acute{\upsilon}$, in Plato's description of the middle (62D3-4), as $\tau\acute{\alpha}$

καταντικρύ: 'noto che τὰ καταντικρύ poche linee prima non è che una parafrasi per indicare ancora il centro'.

Failure to appreciate the point that the lack of difference lies in no one part being *closer* to the centre leads to the idea that no one part of the circumference is *farther distant* from the centre, 'magis distantem', 'plus éloigné', 'more distant', as in August F. Lindau, *Platonis 'Timaeus'* 105, in Victor Cousin, *Oeuvres de Platon* xii (Paris, 1839) 182, and in Henry Davis, *The works of Plato* ed. H. Cary, ii (London, 1849) 372.

On the other hand, essentially the right translation is given by a number of German scholars, Karl E. C. Schneider, *Platonis opera* ii (Didot, Parisii, 1846) 227, Friedrich W. Wagner, *Platons Werke* Theil xv (Leipzig, 1853) 113, Hieronymus Müller, *Platon's sämtliche Werke* Band vi (Leipzig, 1857) 185, and more recently by Otto Apelt, *Platons Dialoge 'Timaios' und 'Kritias'* (Leipzig, 1922) 95-6, by Kurt Hildebrandt, *Platon, 'Timaios' und 'Kritias'* (Leipzig, 1942) 95, and in a translation prepared jointly by Kapferer and Fingerle, *Platons 'Timaios' ... übersetzt und erläutert* 74. Thus I was delighted to find that Apelt's translation was similar to my own, with the exception only of the translation of δῆ:

'Der Umkreis ist weder selbst die Mitte noch hat er irgendeinen von dem anderen abweichenden Teil in sich, der etwa näher nach dem Zentrum hin läge also irgendein Punkt auf der gegenüberliegenden Seite des Umkreises.'

English translations, even apart from those by Cornford and Taylor, have failed to profit from this German tradition. The Loeb edition, by Robert G. Bury (London and New York, 1929) 159, keeps ἢ as 'or'. The Everyman version by John Warrington (London and New York, 1965) 84, translates neutrally 'in relation to the centre', as Archer-Hind, edn 231, had also done. An exception is the Penguin translation by Henry D. P. Lee (Harmondsworth, 1965) 87, which rightly has '... closer to the centre than any part opposite to it'.

Translations into other languages contain fresh anomalies. "H as 'or' reappears in a Dutch translation, by Jan Prins, together with an eccentric rendering of the subject of the sentence as 'the circumference, no more than the middle ...', *Platoon's 'Timaios', in het nederlandsch overgebracht ... door J. P.* (Antwerpen & Den Haag, n.d.) 94-5:

'En van den omtrek, evenmin als van het midden, kan men zeggen dat hij eenig deel heeft, dat zich anders dan eenig ander deel tot het midden verhoudt, of iets van het omgekeerde.'

Emidio Martini retains the neutral sense of μάλλον, and also elides the two genetives, θατέρου and τῶν καταντικρύ (the points B and C in my diagram), *Platone, 'Timeo', 'Critia', 'Minos', traduzione di E. M.* (Torino, 1935) 73-4:

'... e quello (*sc.* luogo), che è alla periferia, non è certo nel mezzo, nè ha alcun punto di sè che, rispetto al mezzo, sia in un rapporto differente d'un altro qualsiasi de' punti < situati > nel lato opposto.'

Martini here brings out nicely the illogicality inherent in Fraccaroli's interpretation and which Fraccaroli himself had rightly commented upon: namely that with his interpretation it is impossible to see why 'any' point on the circumference (*cf.* ἕτερον θατέρου = C in my diagram) should then be specified as one of the parts that are 'opposite' (τι τῶν καταντιπρῶ = B in my diagram). It is true that on the interpretation I have offered the points C will strictly *include* the points B. But, as I have explained, it is in fact easy to see the difference in function between B and C, once we distinguish the two comparisons, and see that the second comparison is intended as a justification of the first: 'any one point on the circumference (A) is no different from any other (C), in being closer to the centre than whatever parts (B) are opposite to it.'

Albert Rivaud, in the Budé edition, *Platon, œuvres complètes* x (Paris, 1925) 186, translates rather oddly that no part *either* is different from another *or* is nearer to the centre: '... nulle de ses parties n'est différente d'une autre, ni plus proche du milieu ...'. Joseph Moreau's translation, in *La bibliothèque de la Pléiade*, ii (Paris, 1942) 486, appears to reflect the notion, also in Taylor, in the passage I have quoted (p. 10 above), that it is the centre which is opposite to the points on the circumference:

'... il n'a pas en lui de parties distinguées, l'une différant de l'autre pour être plus vers le centre que l'un quelconque des points dont ce dernier est l'opposite.'

This latter idea—that the 'parts which are opposite' (τῶν καταντιπρῶ, 62D10) are opposite *to the centre*—does, it is true, have the advantage that in the original definition it is indeed the centre which is said to be 'opposite' to the extremities (ἐν τῷ καταντιπρῶ, 62D3-4). But although the repetition may make it superficially plausible that καταντιπρῶ should have the same reference in both sentences, the meaning that results will not, I think, stand up to inspection: for in that case the present sentence will mean that no point on the circumference will be closer to the centre than *any* point on the circumference—including therefore the point first thought of. The minimal correction will have to be that no point on the circumference is closer to the centre than any *other* point on the circumference. But instead of making that correction it is, I think, easier to adopt the meaning that no point on the circumference is closer to the centre than any of the points that are opposite *to the point first thought of*, so repeating the initial definition of the circumference as made of parts 'standing back an equal distance from the centre' (62D1-2), and with on-

ly the slight anomaly I have already noted (p. 14 n. 18 above), whereby the 'points opposite' are pluralised in order to exclude, as it were, any one of a number of possible points.

Nonetheless, the opposition between different points on the circumference is, I would admit, exceptional: Plato's primary point remains that centre and circumference are in opposition. Thus the 'opposite places' which in the original naïve view of the universe 'divide the whole between them' (*cf.* τόπους ... ἐναντίους, 62C5-6) are reinterpreted by Plato, in his initial definition, as an opposition of centre and circumference (*cf.* καταντικρύ, 62D4), and it is the opposition of place between centre and circumference which Plato then makes use of in his combined account of weight and direction (*cf.* τόπον ἐναντίον ... κατὰ τὸν ἐναντίον τόπον, 63D4-E7; for the difference between Plato's view and the earlier naïve view of the universe, *cf.* pp. 188-91 above, and see further Note 9, pp. 387ff. below). This opposition, however, in the present sentence, finds an echo, I suspect, not in καταντικρύ, but in δῆ. This particle, when it is not ignored, is translated variously as 'of course' (Taylor, Cornford, Lee) or as 'selbst' (Apelt, whose translation I quoted earlier in this Note). Denniston says no more than that the meaning in the present passage is 'emphatic', *Greek particles* 262, *cf.* 259. I take the nuance to be rather one of ironical and even dismissive amusement: 'You're not going to tell me that the circumference is the centre ...'. The implication of the whole I therefore take to be that: 'The circumference is hardly likely to be central (*sc.* since centre and circumference are opposites) nor <even> is any one part of it more closely related to the centre ...'.

(To support this sense of δῆ, the reader may expect me to appeal to the note of 'slight depreciation' which De Vries sees in δῆ at *Rep.* 367C-D. According to De Vries, Adeimantus, with all the carelessness of youth, here repeats from 357C the list of things that the aged Socrates had claimed were good in themselves and beneficial in their effect, as ὁρᾶν, ἀκούειν, φρονεῖν, καὶ ὑγιαίνειν δῆ: '... yes, and health too, if you like', *Mnem.* ser. 3^a, 13 [1947] 202. But De Vries has confused the speakers in the dialogue: it is not the aged Socrates, but the still youthful and impetuous Glaucon who initiates the list at 357C. In the later passage, δῆ may still have the meaning De Vries wishes; but if so, not for the reason he has stated.)

There remains as a difficulty in the sentence, so far as I can see, only the slight anacolouthon between διάφορον and μᾶλλον. I have translated (p. 15 above) 'different ... *in being* closer'. Even as it stands the Greek in Burnet's text is perhaps sufficient to support this; but it is perhaps tempting to consider repeating the final syllable of μᾶλλον, as having been omitted by haplography, and to read μᾶλλον <ὄν>.

NOTE 2

ANAXIMANDER (CF. *TIM.* 62D12-63A2)

Plato claims that a body poised at the centre of a spherical universe would not be drawn to any one point on the circumference more than to any other (*Tim.* 62D12-63A2). I have taken Aristotle's attribution of this idea to Anaximander (*De caelo* ii 13, 295b10-296a23, cf. *Phys.* iv 8, 214b31-215a1) as sufficient evidence for the existence of an implied allusion to Anaximander in the *Timaeus*, as also in a parallel passage in the *Phaedo* (108E4-109A7; cf. pp. 15-17 above). Aristotle's attribution to Anaximander is in fact repeated in Hippolytus, *Ref.* i 6.3 (DK 12A11). Simplicius, *De caelo* 532.13-14 (not in DK), attributes to Anaximander both this idea and the more common belief that the earth is supported by the air beneath it.

The truth of Aristotle's evidence is questioned, notably by J. Robinson, 'Anaximander and the problem of the earth's immobility', *Essays in ancient Greek philosophy*, edd. J. P. Anton, G. L. Kustas (New York, 1971) 111-18. Robinson concludes, p. 117: 'It seems to me clearly impossible in the face of the available evidence to take seriously Aristotle's ascription of the view of the *Phaedo* and the *Timaeus* to Anaximander.' The question undoubtedly requires further examination, especially in the light of Simplicius' evidence; but Robinson's reasoning seems to me far from cogent. In particular Robinson seems to me to falsify the doxographical bases for our knowledge of Anaximander; it will therefore perhaps be enough if I review here briefly the succession of doxographical errors on which his conclusion depends.

Robinson misunderstands the doxographical character of the *Timaeus* itself, for he appears to imply (p. 113) that if Plato had drawn his account from Anaximander he would have said as much, either in the *Phaedo* or in the *Timaeus*. But Zeller had already emphasised the obvious: 'Der Timäus überhaupt keinen von den früheren Philosophen nennt' (*AGPh* 5 [1892] 446; see also Zeller's article, 'Plato's Mittheilungen über frühere und gleichzeitige Philosophen', *ibid.* 165-84, and cf. *Philosophie der Griechen* ii 1, 399 n. 2). Plato's silence is no guarantee that the *Timaeus* is innocent of all borrowing from the Presocratics.

Robinson takes up the point that Aristotle's formulation in the *De caelo* is reminiscent of Plato's wording in the *Phaedo* and *Timaeus*, apparently wishing to suggest that Aristotle's attribution of the underlying idea to Anaximander is therefore fictitious (cf. pp. 112-13). But we have no means of telling whether the wording in Plato may not itself be reminis-

cent of Anaximander; and in any case Aristotle is perfectly capable of clothing an idea taken from Anaximander in wording taken from Plato.

Robinson misrepresents the relation of Theophrastus to Aristotle when he writes that it is 'almost certain' that the information in Hippolytus (*Ref.* i 6.3 = DK 12A11) 'comes from Theophrastus, and so ultimately from Aristotle' (p. 113). The first part of this statement is probably true; the second, almost certainly false. Hippolytus' information on the Presocratics in the *Refutatio* does very probably go back to Theophrastus. But the fragment from Anaximander's own work, recorded in Simplicius (*Phys. op.* fr. 2 = *Dox.* 476), is sufficient proof that what Theophrastus tells us of Anaximander is not necessarily a simple re-hash of what we can read for ourselves in Aristotle. (I have already had occasion to emphasise this point which, obvious though it is, has all too often been neglected or denied: see *JHS* 88 [1968] 120 n. 44, cf. *JHS* 90 [1970] 198-9.)

Robinson confuses the relation between Aristotle and Aetius. It is true that Aetius attributes a similar explanation of the earth's immobility to Parmenides and to Democritus (iii 15.7 = DK 28A44, cf. 68A98), whereas Aristotle attributes to Democritus a different explanation (*De caelo* ii 13, 294b13ff., not in DK). But why should the (supposed) falsity of Aetius' evidence on Democritus be held to invalidate the testimony of Aristotle on Anaximander (cf. Robinson, pp. 114ff.)—the more so as it is Aristotle whose evidence is used to discredit Aetius?

These various errors lead to the claim that 'Aristotle is our *sole* evidence for the existence of the view prior to Plato' (p. 113: Robinson's own italics), and to the further claim that there existed 'a single tradition among the earliest thinkers, one presupposing that the earth has absolute weight, and accounting for its support by imagining it to be flat' (p. 115), with the result that, had Anaximander departed from this tradition, 'the failure of succeeding thinkers to comment upon the fact would be completely inexplicable' (p. 116).

But this conclusion is a travesty of the facts and shows only that by this point Robinson has needlessly discounted, or simply forgotten, much of the evidence from which he began. For on a straightforward reading of the evidence four ancient writers do in fact 'comment', in their own ways, upon Anaximander's theory: Plato, Aristotle, Hippolytus (or Theophrastus) and Simplicius. We could hardly hope for more.

NOTE 3

TAYLOR'S EXTENSION OF PLATO'S THEORY

(i)

The interpretation whereby, in the *Timaeus*, earth is heavier than fire at the centre, but fire is heavier than earth at the circumference, I have referred to throughout my essay as Taylor's interpretation (see esp. pp. 45ff. above), although Taylor is only the most forceful and the most influential exponent of it. Taylor is also distinctive in extending the interpretation to include the comparison between different quantities of the *same* element, so that a larger quantity of fire would be heavier at the circumference but lighter at the centre, while a larger quantity of earth would be heavier at the centre, but lighter at the circumference. Hence Taylor's double conclusion, *Commentary* 440-1 (*cf.* pp. 45-50 above):

'If we lived in the region of fire ... we should then call fire heavier than earth and, I suppose, a small stone heavier than a large one.'

The 'reversal' of the comparison between *different* elements is much older than Taylor. It is found, for example, in Martin, who writes of Plato's final definition, *Études* ii 279-80:

'... les pierres, pesantes par rapport à la terre, sont légères par rapport aux régions élevées de l'atmosphère, tandis que les vapeurs, légères par rapport à la terre, sont pesantes par rapport à ces mêmes régions supérieures.'

This is exactly repeated in Archer-Hind, edn 234:

'To adopt Martin's example, in the region of earth stones are heavy and vapour light; but in the region of air vapour is heavy and stones light.'

But Archer-Hind provides a much richer background to the whole idea. He writes initially, 232:

'Fire ... so far from resisting any effort to lift it from the region which earth and water seek, has a natural impulse to fly from it; whence we conceive of fire as absolutely light.'

The Aristotelean formula flows from the pen without a qualm, and Archer-Hind proceeds to apply the same reasoning to earth:

'Could we reach the home of fire ... we should then find that ... earth or water, so far from resisting the effort to remove it from the region of fire, would have a natural impulse to fly off in the direction of earth, and would be "light".'

This leads to the formula, 233: 'The same thing which is light in one region is heavy in another.' This is almost exactly the formula repeated by Cherniss, some sixty years later, *ACPI* 139: 'The body which is heavy in one region of the universe is light in another.' The coincidence between the two formulae would hardly seem to be accidental; and yet one is loth to think that Cherniss can have been impervious to the background of the idea which in that case he has chosen to repeat: the blatant borrowing from Aristotle, the blithe insouciance of the repetition from Martin.

The continuation of Archer-Hind's commentary only makes matters worse: especially revealing is the way in which the formula I have quoted comes to be grafted onto Plato's final definition (63E3-7). Plato there writes that 'the journey towards its native element makes the body which travels thither "heavy"', and makes the place towards which such a body travels the place "below"', adding, in a formula characteristic of his writing in the *Timaeus* (63E6-7), τὰ δὲ τούτοις ἔχοντα ὥς ἐτέρως θάτερα. Given the preceding examples, this will most naturally mean simply that the body which travels away from its native element will be reckoned as 'light' and as moving 'upwards'. The final definition will then be no more than a generalising repetition of the lesson which Plato had drawn from the comparison of fire with fire (63B2-C5) and of earth with earth (63C5-D4). The larger quantity of earth or of fire travels towards its parent body (earth therefore towards the centre, fire towards the circumference) and is reckoned as 'heavy' and as moving 'downwards'. The smaller quantity of either element, in moving away from its parent body (*cf.* ἐτέρως), will be reckoned as 'light' and as moving 'upwards' (*cf.* θάτερα).

Not so Archer-Hind. For Archer-Hind, the whole of his preceding—and purely imaginary—exegesis is already present to the eye of the imagination, and he takes Plato's simple—though admittedly enigmatic—formula to imply, not the comparison between different quantities of the same element, but a comparison between different elements. Thus he takes Plato's principal formula (63E4-6) to mean that, measured at the centre and at the circumference respectively, earth and fire, independently of any calculation of quantity, will be seen to move each towards its parent element, and that both earth and fire will then be reckoned as 'heavy' and as moving 'downwards'. Plato's enigmatic abbreviation (63E6-7) he then takes to mean that earth which moves towards its parent element from the circumference, and that fire which moves towards its parent element from the centre, will both be reckoned as 'light' and as moving 'upwards'. The result of the two formulae is therefore that measured at the circumference fire will be heavy and earth light, and that

measured at the centre earth will be heavy and fire light. This at least is the meaning which I think must attach to the following note (edn 234), which is almost as enigmatic as the text which it purports to explain:

'By τὰ δὲ τούτοις κ.τ.λ. Plato means that while in a given region we apply the term βαρύ to a substance whose ὁδὸς πρὸς τὸ συγγενές is towards that region, we apply the term κοῦφον to a substance whose ὁδὸς πρὸς τὸ συγγενές is towards another.'

It is worth observing just what has happened here. Archer-Hind has smuggled into Plato's complete formula (63E4-6) the hidden stipulation that a body which moves towards its parent element must be measured 'in a given region' and as moving 'towards that region'. This hidden stipulation is then the feature which Archer-Hind chooses to reverse for the expression ὡς ἐτέρως θάτερα (63E6-7), so that in that expression we have to envisage a body which moves towards its parent element, starting from 'a given region' and moving 'towards another'. In this way, measured at the centre ('in a given region'), earth which moves towards its parent body (and so 'towards that region') is 'heavy' and moves 'downwards', while fire, which moves towards its parent body (starting from the same region, and moving 'towards another') is 'light' and moves 'upwards'. Once the same calculation has been made for the measurement of earth and fire at the circumference, we arrive therefore at Archer-Hind's general interpretation of Plato's theory: earth which is heavy at the centre will be light at the circumference. 'The same thing which is light in one region is heavy in another' (Archer-Hind, p. 233).

I have already emphasised that this interpretation has no place in Plato's text. In his account of weight and direction (63A6ff.), Plato makes no comparison between different elements, nor is there any claim that measured at the circumference earth would be light instead of heavy (see esp. pp. 45ff. above). In the final definition (63E3-7), as throughout his analysis (63A6ff.), Plato's comparison lies between different quantities of a single element, earth at the centre and fire at the circumference. In the concluding formula (63E6-7), ὡς ἐτέρως is most simply taken as reversing the description 'towards its native element', and so as meaning 'away from its native element'. The final θάτερα is then most simply taken as meaning that the body which moves away from its native element is to be reckoned as 'light' and not as 'heavy', as moving 'up' instead of 'down'.

As against this, Archer-Hind's interpretation has only to be spelt out in detail for it to be at once apparent how arbitrary, and indeed nonsensical, it is. For the stipulation 'in a given region'/'towards that region' to be only implicit in the earlier part of Plato's formula (63E4-6) is in itself difficult enough. But for this stipulation, which has not even been ex-

pressed openly, then to be 'reversed' in the formula ὡς ἐτέρως θάτερα (63E7), so as to have the meaning 'in a given region'/'towards another', with the result that earth, for example, which had been heavy, is now light, flies in the face of what is possible, even in the extraordinarily intricate and abbreviated Greek of the *Timaeus*.

The fact that Archer-Hind should propose such an interpretation shows how completely oblivious he is to the extreme perversity of his whole interpretation, as a reading of Plato's text. It is indeed difficult to imagine how such a fanciful elaboration of the printed word could have been put forward with such seeming confidence by a man of intelligence, until one recognises that in many places, as Cook Wilson rightly saw, Archer-Hind's commentary is no more than a *pot pourri* of other people's ideas. For the truth is that Archer-Hind was only incidentally concerned to elucidate the intricacies of a particularly difficult treatise. His passion was to feed into the text of the *Timaeus* the loose Hegelianism which was then fashionable in the quiet courts of Trinity (see esp. pp. 28ff. of his Introduction), just as forty years later Taylor will scan the pages of the *Timaeus* for the dazzling Idealism soon to be brought from London to Edinburgh by another fellow of Trinity (A. N. Whitehead, Gifford lecturer 1927 and 1928).

(ii)

What is more surprising is that this same interpretation should have been repeated, thoughtlessly and without challenge, for well nigh a century. Élie Halévy, *La théorie platonicienne des sciences* (Paris, 1896) 294: 'Ce qui est lourd en un lieu est léger en un autre.' Constantin Ritter, *Platon, sein Leben, seine Schriften, seine Lehre* ii (München, 1923) 327-8: '... und so wäre ihnen das Feuer schwer, das uns leicht ist.' This is repeated verbatim in *Die Kerngedanken der Platonischen Philosophie* (München, 1931) 216. Claghorn, *Aristotle's criticism of Plato's 'Timaeus'* 52: 'The net result (*sc.* of Plato's theory) will be that what is light in one region is not light in another; and conversely, that what is heavy in one region is not heavy in another.' This seems also to be the intention of the rather oracular utterance in Ottomar Wichmann, *Platon, ideelle Gesamtdarstellung und Studienwerk* (Darmstadt, 1966) 450: 'Widerstand, wenn etwas zwangsmässig aus der ihm zukommenden Örtlichkeit entfernt werden soll, ist Schwere, bedeutet aber bezüglich anderer Örtlichkeit Leichtigkeit.'

Is even Cornford innocent of Taylor's interpretation, as I have rather assumed in writing earlier that he allows Taylor's interpretation to pass 'without correction' (p. 45 above)? Cornford writes of Plato, in one brief sentence, *Cosmology* 265:

'He can explain why one mass *feels* heavier (or lighter) than another, and how it will depend on the situation of the observer whether it feels lighter or heavier.'

This sentence—untypically for Cornford—is ambiguous. It could be taken, innocently enough, as meaning only that a quantity of earth which initially seems 'light' may later appear 'heavy', if it is compared with a smaller instead of a larger piece of earth. But in that case is it really 'the situation of the observer' that has changed? Has Cornford not perhaps instead assumed, as so many of his predecessors had done, that if the observer could move from centre to circumference then the body which had seemed heavy would now seem light? When even Cornford is not only wrong, but unclear, and seemingly even unconscious of the point at issue, then there can be little hope in looking further for allies in a darkened world.

(iii)

Certainly, Cherniss falls prey to the interpretation which stems from Taylor and from Martin. In a formula which, as I have noted, is only slightly adapted from the wording that we find in Archer-Hind, he writes, *ACPl* 139: 'The body which is heavy in one region of the universe is light in another.'

There is however a crucial ambiguity in this formula, and in Cherniss' account generally. Does Cherniss mean to adopt only the feature of Taylor's interpretation which Taylor shares with Martin, i.e. the comparison between *different* elements, or does he mean to go further and to adopt the feature which is peculiar to Taylor's interpretation of the *Timaeus*, the 'reversal' of the comparison between different quantities of the *same* element (*cf.* p. 179 n. 10 above)?

I am not sure that I have been able to resolve the seeming inconsistency in Cherniss' account at this point. When Cherniss first employs the expression I have quoted (*ACPl* 139), he fairly clearly intends to paraphrase Plato's definition of weight by resistance (62C3ff.), and it is therefore tempting to suppose that he means to compare different quantities of the *same* element: the larger quantity of fire, for example, which is heavier at the circumference is lighter at the centre. But in the accompanying footnote (*ACPl* 139 n. 85), Cherniss writes of fire as 'lightest', apparently wishing to paraphrase Plato's initial account of weight as defined by number, and therefore to envisage the comparison between *different* elements. The meaning of the paradox would then be that fire, for example, which is heavier than earth at the circumference is lighter than earth at the centre; hence Cherniss' contention (*ACPl* *ibid.*) that it is fire which

is measured at the centre which is said to be 'lightest' (56B1). This therefore—the comparison between *different* elements—one is tempted to suppose will be the comparison which Cherniss will have had in mind in the body of his text.

Or is the truth perhaps that Cherniss has simply failed to think the matter through? Since both comparisons are present in Taylor's interpretation, Cherniss perhaps has both comparisons confusedly in mind, and has failed to distinguish between them.

One other writer adopts both features in Taylor's interpretation. The summary Stratton provides of Plato's theory, in his commentary on Theophrastus' *De sensibus*, pp. 205-6, is a rather muddled repetition of Taylor's interpretation of Plato, and includes both the comparison of different elements and the comparison between different quantities of the same element: fire is heavier than earth at the circumference, and lighter than earth at the centre; the larger quantity of earth is heavier at the centre and lighter at the circumference, and *vice versa* for fire.

More interestingly, in the continuation of his commentary Stratton repeats from Taylor a curious counterpart to an argument that I have already noted in Cherniss. Cherniss claims that fire which has fewest 'planes' and which Plato tells us is 'lightest' is intended to be fire which is measured at the centre (*ACPl* 139 n. 85). The implication is apparently that measured at the circumference fire will be the heaviest element (*cf.* pp. 179-80 above). Stratton (p. 217) records from Taylor an analogous claim for the comparison between different portions of the same element:

'From our point of view, the more of the pyramids which constitute flame there are in the flame the *lighter* it is (with Plato's definition).'

This argument is of some passing interest, in so far as in his *Commentary* Taylor appears to have made no effort to combine, or even to compare, Plato's later and earlier theory (*cf.* p. 124 above). The implication of the argument recorded here by Stratton is apparently that in Plato's earlier theory the definition of fire as lightest because it has *fewest* triangles is intended to apply only to fire which is measured at the circumference; in the later theory, fire which is measured at the centre will be lighter the *more* triangles it has.

The contradiction between Taylor and Cherniss rather prettily brings out the contradiction inherent in Taylor's interpretation as a whole. Plato says that fire is 'lightest' because it is made 'from the fewest number of like parts' (56B1-2). Cherniss, in his note (*ACPl* 139 n. 85), understands this of the comparison between *different* elements, and argues that the fire which is 'lightest' is fire which is compared to earth and which is measured at the centre. Taylor, as reported by Stratton, applies the same

text to the comparison of different quantities of the *same* element, and argues that the fire which is 'lightest' is a smaller quantity of fire compared with a larger quantity, and measured at the circumference.

The contradiction arises because on Taylor's interpretation fire which is measured at the circumference is both heavier than earth and proportionately heavier in the larger quantity, while fire which is measured at the centre is lighter than earth and proportionately lighter in the larger quantity. There is therefore the impossible conclusion that fire which is 'lightest' in virtue of having the *least* number of like parts has to be fire which is measured at the *centre* for the comparison of *different* elements (Cherniss' argument) and fire which is measured at the *circumference* for the comparison between different quantities of the *same* element (Taylor's argument). The puzzle is only that Cherniss has so little thought out the consequences of his argument that he apparently presents his claim as a means for the potential conciliation of Plato's two theories, whereas the absurdities it leads to should rather have confirmed him in his belief that Plato's two theories are inconsistent, and that in Plato's definition of weight by resistance 'the implications drawn from the chance remark', on fire as lightest, (56B1) 'are definitely rejected'.

Even apart from their inconsistency, the two arguments, from Cherniss and from Taylor, are hopelessly flawed as an explanation of Plato's text.

I have already noted the irrationality in Cherniss' argument (pp. 179-80 above). In Plato's earlier passage, there is no indication that fire which is 'lightest' is fire which is measured at the centre. In the later passage, there is no indication that Plato intends to compare different elements, and *a fortiori* no implication that measured at the centre fire would be lighter than any other element.

Taylor's argument is no less flawed. In the earlier passage, Plato gives no indication that the rule whereby fire is lightest because it has the smallest number of triangles will be true exclusively of fire which is measured at the circumference. In the later passage, there is no explicit comparison between different quantities of fire measured at the centre, and *a fortiori* no claim that in such a comparison the larger quantity of fire is lighter.

Taylor's interpretation, as also that of Cherniss, requires us in effect to attribute to Plato the exact opposite of what Plato has actually said. Plato tells us, in his later passage (63A6ff.), that a larger quantity of fire is *heavier* than a smaller quantity; Taylor tells us that, measured at the centre, fire is *lighter* in the larger quantity. Plato tells us, in his earlier passage (56B1-2), that fire is the *lightest* element; Cherniss implies that, measured at the circumference, fire will be the *heaviest* element. In other words, in

order to effect the conciliation of the two theories, we have first to import into Plato's earlier theory a restriction of which there is no sign in the text, and whereby fire which is said to be lightest is fire measured either exclusively at the circumference (Taylor) or exclusively at the centre (Cherniss); and we then have to rely, in the later passage, on precisely that feature of the theory which is nowhere explicit in Plato's text: the comparison of different quantities of fire at the centre (Taylor) and the comparison of different elements (Cherniss).

(iv)

It is Cherniss' adoption of Taylor's interpretation which keeps him, or so I have argued, from understanding the criticism which Aristotle makes of Plato (pp. 177-82 above); while fairly clearly it is the same interpretation which underlies, and inhibits, McDiarmid's attempt to explain Theophrastus' criticism of Plato, *Phronesis* 4 (1959) 59-70, esp. 66-70 (*cf.* p. 218 n. 5 above).

McDiarmid has pretty obviously adopted Taylor's reading of Plato's theory. Thus in paraphrasing the definition of weight by resistance McDiarmid writes, p. 67: 'Plato himself asserts ... that, if we took our position in the region of fire, and weighed two masses of fire, the larger would be found to be the heavier; what we call "light", "heavy" ... here in the region of earth are the opposite in the region of fire.' This would clearly seem to imply that the larger quantity of fire, which is *heavy* at the circumference is *light* at the centre, precisely as in Taylor's interpretation of Plato's theory (pp. 45-50 above). Certainly, when McDiarmid comes to repeat and to summarise Theophrastus' criticism of Plato that for earth 'here the smaller quantity is lighter and there the greater quantity is lighter' (p. 70), he does not make it clear whether, or how far, this is divergent from the statement that he has given of Plato's own theory.

Precisely as with Cherniss, this reading of Plato's theory leads McDiarmid to suppose that the earlier theory of weight as defined by number, and where therefore each element must have a fixed weight, will be entirely irrelevant to Plato's later analysis of weight as defined by direction (*cf.* pp. 178-9 above). Thus McDiarmid claims, exactly as Cherniss had done, that Plato's earlier 'remark', on the number of parts in fire, 'has nothing to do with the phenomenon of weight' (p. 68). Coming from McDiarmid's pen, this conclusion is only the more *outré*, since McDiarmid recognises both that the earlier theory is the basis for Aristotle's criticism of Plato and that Theophrastus shares Aristotle's view. He writes, pp. 68-9, that 'Theophrastus accepts the account of Aristotle without stating its source or basis, and in his criticism he puts it on the

same footing as the account that he had taken from the discussion of weight in the *Timaeus*. Why Aristotle and Theophrastus should be so deceived is not a question which McDiarmid ever seems to have asked himself.

The devastatingly inhibitory effect of Taylor's interpretation on modern writers' understanding of the criticisms which Aristotle and Theophrastus make of Plato is neatly epitomised when Moraux writes, in the introduction to his Budé edition of the *De caelo*, cxlvii:

'L'observateur situé dans la zone du feu trouvera, par exemple, que la terre est légère; il la verra monter d'elle-même au dessus de sa tête pour regagner le centre de l'univers. Ces vues platoniciennes, Théophraste les a critiquées en se fondant sur la théorie d'Aristote, mais Aristote lui-même les passe presque entièrement sous silence.'

Moraux's comment is a powerful witness to the prevailing orthodoxy and its stifling effect on any fresh and attentive study of Plato's text. It would be impossible to guess from Moraux's presentation of the problem that the 'vues platoniciennes' which Theophrastus supposedly criticises 'en se fondant sur la théorie d'Aristote' are not at all the theories which Theophrastus claims as being those of Plato himself, but are critical constructions which Theophrastus has himself spun out of his Aristotelean beliefs, and which are intended as a refutation of Plato's theories. The admission that Aristotle himself never refers to these theories should have caused a moment's hesitation. But no: Aristotle is so likely to have misunderstood Plato that his 'silence' can do nothing to warn the historian that the theory which all modern scholars agree on attributing to the text of the *Timaeus*—may not be there at all.

(v)

In these more recent works, however, the connection with Taylor, or with Martin, is unacknowledged, and perhaps unconscious, or even absent altogether. Thus Zannoni, who otherwise shows no knowledge of Taylor or of Martin, writes of Plato's theory, in the introduction to his translation of the *De caelo*, 47:

'Se l'uomo camminasse nella regione del fuoco, ossia nella regione periferica del cosmo, coi piedi dunque sulla superficie interna della sfera e col capo rivolto verso il centro, non chiamerebbe più "alto" la periferia e "basso" il centro della sfera come quando camminava sulla superficie della Terra, ma "alto" il centro che penderebbe sul suo capo e "basso" la periferia sulla quale egli poggerebbe i piedi. Di conseguenza egli chiamerebbe "pesante" il fuoco, come discendente dal centro verso la regione che gli sta sotto i piedi, "leggiera" la terra moventesi verso quel centro dell' universo che gli pende sul capo, e che egli chiama "alto".'

The account, in the final clause, of earth measured at the circumference is purely imaginary and arbitrary. 'Di conseguenza' betrays the origin of the idea. Zannoni has come to see the measurement of earth at the circumference as actually present in the text of Plato, guided, possibly by his memory of Taylor or Martin, but otherwise simply by the tendency, seemingly ineradicable in many writers on early philosophy, to spell out the rhythmical consequence of a set of ideas, with no regard for historical or textual justification, and with little concern for the intrinsic merit or necessity of the consequence.

Once he has decided that Plato's scheme must include the measurement of earth at the circumference, no less than at the centre, Zannoni is apparently guided by the assumption that earth which moves from circumference to centre will be reckoned by the imaginary observer at the circumference as moving 'upwards', since for the observer at the circumference centripetal movement will be movement 'from foot to head'. Zannoni then retains the association by which the body which moves upwards is light, with the result that earth measured at the circumference is both 'light' and moves 'upwards'.

The obvious difficulty in this conception is that it runs clean counter to Plato's affirmation, in his final definition, that the journey of a body towards its native element is to be reckoned as movement 'downwards' (63E3-7). Zannoni has failed in effect to pass from the point of view of the observer to the point of view of the element, as we must do, if we choose to calculate the movement of an element in a region opposite to its own (*cf.* pp. 62ff. above). So long as we restrict ourselves to calculating the movement of an element whose 'home' is that region of the universe where we make the observation, then of course this problem does not arise: there will be so to speak no conflict between the movement of the element and the calculation of the observer. Thus for the imaginary observer at the circumference the movement of fire away from the circumference will be movement 'upwards', both because fire is moving away from its parent body and because the movement in question is, for the observer, movement 'from foot to head'. But so soon as we attempt to measure the movement of an element in a place other than its own, then there is no longer the same coincidence between the movements of the element itself and those movements which appear 'normal' to the observer. Earth which moves from circumference to centre is moving towards its native element, and according to Plato's final definition therefore this should be reckoned as movement 'downwards', although, for the observer, this is movement 'from foot to head', and movement therefore which he would more usually think of as movement 'upwards'.

Martin himself had happily embraced the paradox inherent in this 'extension' of Plato's theory. For Zannoni, the imaginary observer at the circumference will presumably reckon both fire and earth which move away from the circumference as moving 'upwards', since in that case either element is moving 'verso quel centro dell'universo che gli pende sul capo, e che egli chiama "alto"'. Martin boldly concludes that direction is determined by the movement of the element, and not by the position of the observer, and therefore that what is 'up' for one element will be 'down' for another, and *vice versa*.

'Pour un corps quelconque, le *bas*, c'est le siège principal du genre de corps auquel il appartient, le *haut*, c'est la région opposée; ... ainsi ce qui est le bas pour un corps est le haut pour un autre' (*Études* ii 273).

'Ainsi, suivant Platon, ce qui est le bas par rapport à une pierre est le haut par rapport au feu et aux vapeurs plus légères que l'air' (*Études* ii 279).

It follows that for Martin the oppositions of weight and of direction are no longer aligned as they are in Plato's final definition (63E3-7). For in the continuation of the second passage (*Études* ii 279-80, quoted at the beginning of this Note), Martin tells us that stones are light when measured at the circumference and that 'les vapeurs' are light when measured at the centre. It will apparently follow therefore, on Martin's scheme, that earth will be *light* in the region of fire, but will be moving *downwards* when it is moving away from the circumference, and that fire will be *light* when measured in the region of earth, although it will be moving *downwards* when it is moving away from the centre. But Plato had told us clearly that the body which is *light* moves *upwards*, and that the body which is *heavy* moves *downwards* (esp. 63E3-7).

(vi)

Taylor manages to avoid this contradiction, but only at the cost of inconsistency. Thus in a passage already quoted (*Commentary* 440-1, see p. 45 above), Taylor first writes that: 'Anything is easy to dislodge from an "alien" region in the direction of its own, and the more there is of it, the less effort is required for its expulsion.' Here the region which is 'alien' is clearly intended to be 'alien' to the element. Taylor then writes: 'That is heavy which it is hard to shift into a foreign region.' This is ambiguous. It is most naturally taken to mean again a region 'foreign' to the element, as in the sentence preceding. But it could be taken to mean instead a region 'foreign' to the person who does the shifting, and this is in fact the meaning which the equivalent expressions have in the final sentence of Taylor's commentary: 'The key to the whole doctrine is to understand

that to an observer anywhere in the universe “up” means out of his own “region” into the adjacent region.’

Thus Taylor has in practice employed two different, and inconsistent, criteria for measuring weight and for calculating direction.

1. The measurement of weight is determined by the relation of the element to the region which is peculiar to itself. (‘Anything is easy to dislodge from an “alien” region in the direction of *its own* ...’, my italics.)

2. But the calculation of direction is determined by the relation of the element to the region which is peculiar to the observer. (‘To an observer anywhere in the universe “up” means out of *his own* “region” ...’, my italics.)

By the *first* criterion, earth which is moved from the circumference (since it is ‘easy to dislodge from an “alien” region in the direction of its own’) will be light. By the *second* criterion, earth which moves away from the circumference (since ‘to an observer anywhere in the universe “up” means out of his own “region”’) will be moving upwards. The result is consistent (earth which is *light* moves *upwards*), but the criteria employed are different: weight has been determined by the region proper to the element; direction has been determined by the region proper to the observer.

But even inconsistency cannot save the appearances, when Taylor moves from the comparison of different elements, to the comparison of different quantities of the same element.

1. Thus to take Taylor’s own example, the observer at the circumference finds it more difficult to expel a small stone, since the small stone is returning to the region peculiar to itself, and the small stone is therefore heavier than the large one. (For ‘... the *more* there is of it, the *less* effort is required for its expulsion’, my italics; from which I infer that the *less* of it there is, the *more* effort will be required.)

2. But at the same time the small stone is moving upwards, since it is moving out of the observer’s ‘own “region”’ and ‘into the adjacent region’.

Therefore the stone which is *heavier* is nonetheless moving *upwards*, contrary to Plato’s repeated assumption that what moves ‘up’ is ‘light’ and that what moves ‘down’ is ‘heavy’ (63A6ff., esp. E3-7).

It is true that we fare no better if we correct this feature in Taylor’s interpretation, so as to have direction determined by the movement of the element, and not by the position of the observer. For in that case it is the

direction of the larger stone which is anomalous. For both the larger and the smaller stone will be moving 'downwards' (i.e. towards their own region) when dislodged from the circumference, and yet, since the larger stone (according to Taylor) is easier to dislodge and therefore 'lighter', we now have the anomaly that the body which is *lighter* is moving *downwards*.

For the truth is that in *either* case we have the insuperable difficulty that both stones are moving in the same direction ('downwards', if we take the point of view of the element; 'upwards', if we take the point of view of the observer), and yet one stone, according to Taylor, is to be reckoned as 'heavy' and the other as 'light'.

Despite the proud boast, 'It will be seen that the theory of βαρύ and κοῦφον ascribed to Timaeus is completely logical' (*Commentary* 441), I think it is clear that in fact Taylor has quite failed to think out for himself the consequences of the interpretation he has adopted. This is frequently the fate of those who take over an interpretation from someone else and who then think to present it as their own. The difficulties in Martin's own interpretation are serious enough; the difficulties in Taylor's adaptation and enlargement of Martin's interpretation are insuperable.

(vii)

There does remain one possible source of Taylor's interpretation, which I have so far failed to mention. By a process of reasoning which I believe is purely coincidental to this passage in the *Timaeus* Aristotle does at one point in the *De caelo* arrive at a refutation of the idea that the cosmic elements could alter their nature by being closer to or farther away from their natural places, i 8, 276b21-3: τὸ δ' ἀξιοῦν ἄλλην εἶναι φύσιν τῶν ἀπλῶν σωμάτων, ἂν ἀποσχῶσιν ἑλαττον ἢ πλεῖον τῶν οἰκείων τόπων, ἄλογον. If we specify 'nature' in terms of heavy and light, as in Aristotle's theory we are entitled to, then we may think to find here precisely the formulation that Taylor finds in Plato's *Timaeus*: fire is heavier at the circumference in a larger quantity, and lighter when it is at the centre and farther from its natural place.

But it is clear, I think, that Aristotle has no thought of the *Timaeus* at this point (276a30-b25). His argument is directed against the possibility of there existing worlds other than our own, and the idea is that earth or fire in another cosmos would be farther away from its natural place in this world (or *vice versa*), but that neither element could be expected to have a different nature therefore. The argument is that fire in the one cosmos would have to move towards the centre of its own cosmos in order to arrive at the circumference of the second cosmos, while earth in the one

cosmos would have to move towards the circumference of its own cosmos in order to arrive at the centre of the second cosmos. But for earth to move towards the circumference, or for fire to move towards the centre, of its own cosmos would require the 'nature' of fire or earth 'to change' (ἄλλην εἶναι φύσιν), in virtue solely of the fact that in the one world fire or earth would find itself farther from its natural place, if its natural place is reckoned as the circumference or the centre of the second world.

The argument is a trifle tortuous, because Aristotle assumes both that the circumference of the second world would act as the natural place, and as the focus of attraction, for fire in the first world, and also that fire would be moving contrary to nature in moving away from the circumference and towards the centre of its own world. But the quality of the argument is beside the point. I have introduced the argument, not because I believe it has in fact any significance for our analysis of the *Timaeus*, but simply because the striking—but as I believe purely coincidental—resemblance between Aristotle's formulation and Taylor's interpretation could be misleading, if taken out of context.

NOTE 4

TRIANGLES

(i)

From Plato's general theory of the geometrical solids and their rôle in the cosmology of the *Timaeus*, there are only two points which are relevant to the theory of weight that I have thought to re-establish in the course of my essay: these are the size of the elemental, or more strictly of the subelemental, triangles, and the question of the existence of void. On both points I have so far stated only what seem to me the barest essentials, leaving for this Note and the next the more controversial aspects of either point.

Thus I have hoped to present Cornford's thesis, which would make the subelemental triangles (half-squares and half-equilaterals) ultimately equal in size as well as the same in kind (and therefore congruent), in a form which would be immune to the criticisms made of Cornford's thesis by Karl R. Popper, *The open society and its enemies*, revised edn (Princeton, 1950) 525-31 (= ch. 6 note 9), by Charles Mugler, *La physique de Platon* (Paris, 1960) 21-6, and by W. Pohle, 'The mathematical foundations of Plato's atomic physics', *Isis* 62 (1971) 36-46. (See pp. 84-7 above for my reformulation of Cornford's thesis, *Cosmology* esp. pp. 230-9.)

The thesis that the subelemental triangles are all ultimately equal in size is easily separable from the point made much of by Pohle, namely Cornford's suggestion that part of the purpose of Plato's scheme is to prevent the larger surfaces or corpuscles being visible. For quite apart from the mathematical complexities of the question, this feature of Cornford's thesis is sufficiently excluded by Plato's explicit assertion that 'many' elemental bodies are needed to make up a body that would be visible to us. Clearly, the elemental bodies, like the atoms of Democritus, are much too small to be visible. (On the size of Democritus' atoms, see vol. i pp. 282-98, and 'Préjugé et présupposé en histoire de la philosophie: la taille et la forme des atomes dans les systèmes de Démocrite et d'Épicure', *La Revue philosophique de la France et de l'étranger* année 107 tome 172 [1982] 187-203.) There seems to me no need to suppose, nor any reason to assume, that Plato was preoccupied with the visibility of even the largest grade of solids, in his exposition of the theory of the *Timaeus*.

(ii)

Mugler's criticism of Cornford centres on the same point as that made by Pohle, only arrived at by a different route. Mugler claims that there is

an infinite range in the differences of size that attach to the triangles, although the number of triangles of any one size is finite. It then follows that if the smallest subelemental triangle is finite in size, as Cornford believes, and if any increase in size is the result solely of the addition of such triangles, then some of the triangular faces which result will be infinite in size and therefore visible. If I have understood his rather convoluted argument aright, Mugler himself avoids this unwanted conclusion by supposing that there is no 'smallest common denominator' to the different grades of triangle; the infinite gradations of size, for the two 'original' triangles, the half-square and the half-equilateral, all fall below an upper limit of magnitude, as in the progression 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, etc.

Fortunately, however, there is no need to pursue the internal ramifications of Mugler's own hypothesis, since as often with this author the inordinate length and complexity of the demonstration stems from a simple error of fact, in this case an obvious mistranslation of *Tim.* 57D3-5. According to Mugler (p. 25), Plato here writes that the triangles 'accusent une variété infinie de grandeur'. But this is not so. In the lines preceding (57D2-3), Plato tells us that the different grades of triangle are 'as many as are the *gene* which are to be found in the *eide*'. In this context, the *eide* are the four Empedoclean elements, whose association with the geometrical solids has been described in the preceding pages of the *Timaeus* (53C4ff.); 'the *gene* which are in the *eide*' are the different varieties of each element, which Plato is about to enumerate and describe in the pages of the *Timaeus* almost immediately following (58C5ff.; cf. pp. 108ff. above). Plato's meaning is therefore that there is a different size of triangle for each of the different 'kinds' of earth, air, fire and water. There is no indication at all in Plato's argument that these 'kinds' are infinite.

'Infinity', in Plato's account, attaches, not directly to the different grades of triangle, but to the various combinations that can be produced from triangles of the same and of different grades, i.e. when the triangles are 'mixed with themselves and with each other', 57D3-5: διὸ δὴ συμμειγνόμενα αὐτά τε πρὸς αὐτὰ καὶ πρὸς ἀλλήλα τὴν ποικιλίαν ἐστὶν ἄπειρα.

Mugler, however, takes this sentence differently. He attaches the designation ἄπειρα, not to the combinations produced by the triangles, but directly to the triangles themselves. He writes, p. 25:

'Dans le texte de Platon, les mots συμμειγνόμενα αὐτά τε πρὸς αὐτὰ καὶ πρὸς ἀλλήλα n'expriment pas une condition pour τὴν ποικιλίαν ἐστὶν ἄπειρα, mais constatent un fait indépendant, le mélange étroit, c'est-à-dire la distribution fortuite, des triangles dans la réalité, et le passage signifie: "... ces triangles, qui se trouvent étroitement mélangés les uns avec les autres, accusent une variété infinie de grandeur".'

But this strained interpretation can be shown to be inaccurate on grounds both of practice and of theory.

Plato's practice is in fact to employ more than one grade of particle in his explanation of the variety of sensible substance. Thus Plato first divides the 'kinds' of water into the 'liquid' and the 'fusible' (58D4-5; *cf.* p. 83 above): 'fusible' water is made from large particles, and is used especially in the make-up of metals (58D8-59D2); 'liquid' water is made from 'small' or 'fine' particles, and is used to explain the formation of hail, ice, snow and hoarfrost (59D2-E5; *cf.* 58D5-8). For both kinds of 'water', use is made of more than one grade of particle. Thus for 'liquid' water, there is a whole range of substances formed when 'the greatest number of <different> kinds <of the smaller grades> of water are mixed with each other' (*cf.* τὰ δὲ δὴ πλεῖστα ὑδάτων εἶδη μεμειγμένα ἀλλήλοις, 59E5ff.); these are 'juices' (χυμοί), and particularly wine, oil, honey and *opos* (59E5-60B5; for my earlier account of this passage, see pp. 115-17 above). Further variety still is added by the use of more than one element: the four kinds of 'juices' that Plato has named are all 'fiery' kinds (*cf.* ἔμπυρα εἶδη, 60A3). There is the same duplication in Plato's explanation of metals, made from the 'fusible' grades of water: copper differs from gold, both in being made from more than one grade of the <larger-sized> particles of water (*cf.* εἶδη δὲ πλείονα ἐνὸς ἔχον, 59B6), and also in possessing an admixture of earth (59B7-8; for my earlier analysis of this passage, see pp. 89-96 above).

This is Plato's practice; it is also his theory. When Plato has completed his enumeration of all the various substances derived from the triangles, he repeats the principle by which these various substances have been formed, 61C3-4: καὶ τὰ μὲν δὴ σχήμασι κοινωνίαις τε καὶ μεταλλαγαῖς εἰς ἄλληλα πεποικιλμένα εἶδη σχεδὸν ἐπιδέδεικται. 'The *eide* have now been well enough displayed, in the variety produced by their shapes, by their joining together, and by their transformations into one another.'

In this concluding sentence, Plato writes specifically that 'variety' has been produced by the 'joining together' or 'mingling' (κοινωνίαις, 61C3) of the particles, as indeed had been obvious from the account of the *eide* in the pages preceding. It is therefore perverse to deny the equivalent meaning to the sentence which precedes and introduces Plato's account (57D3-5, quoted earlier). The meaning will be not, as Mugler wishes, that the triangles '*which happen to be mixed*, display infinite differences of size', but that the triangles '*by being mixed*, with themselves and with each other, are "infinite" in variety.' (Note especially the repetition: ποιικιλίαν in the opening sentence, 57D5, and πεποικιλμένα in the concluding sentence, 61C4.)

Once Plato's introductory sentence (57D3-5) has been understood correctly, then Mugler's attempt to attach 'infinity' directly to the different grades of triangles, falls to the ground. Plato's point will be, not that the triangles themselves 'accusent une variété infinie de grandeur', but that the variety which can be produced from their combinations is 'infinite' (ἄπειρα, 57D5).

This interpretation of Plato's sentence affects radically the nature of the 'infinity' which is here called into play. The different sizes of the triangles are only as many as the different 'kinds' of the four Empedoclean elements (*cf.* 57D1-3). There is no indication at all that these 'kinds' are infinite. But if the differences of size in the elemental triangles are finite, then the combinations produced from them, though vastly numerous, will also ultimately be finite. Plato's meaning therefore will be simply that the combinations of the different grades of triangles, and therefore the sensible substances that can be produced from them, are—not mathematically infinite, but merely—'endless in variety' (ποικιλίαν ἐστὶν ἄπειρα, 57D5).

I have troubled to put right, at some length, Mugler's misunderstanding of this crucial passage, on which he founds his criticism of Cornford, because the attempts that have been made hitherto to isolate the error in Mugler's thesis seem to have largely missed the point, with the result that Halleux, for example, can still find in Mugler's argument a 'refutation' of Cornford's thesis (*Le problème des métaux dans la science antique* 86 n. 5). Thus Vlastos had already remarked that ἄπειρα at 57D5 need mean only 'indefinitely numerous' and not strictly 'infinite', *Isis* 58 (1967) 205 n. 8. But Vlastos does not clearly bring out the yet more fundamental error: that Mugler attaches to the differences in size of the triangles themselves the 'infinity' which Plato attaches solely to the combinations that are formed from the triangles. Still less cogent is Cherniss' criticism, *The review of metaphysics* 4 (1950-1) 404: 'Unfortunately Mugler interprets *Timaeus* 57C-D to mean that the elementary triangles, the half-square and the right-angled scalene, exist in different sizes.' But so they do. Both Cornford and Mugler agree that at 57C7-D6 Plato introduces different sizes of the original half-square and half-equilateral. The point at issue is not this fact, 'unfortunate' or otherwise, but whether, as Cornford believes, the difference in size is reducible ultimately to a difference in the number of equal subelemental triangles, or whether, as Mugler believes, there is an infinite range in the differences of size for both kinds of triangle, with no underlying 'common denominator' which would allow transformations between the different grades of cubes, and between the different grades of tetrahedra, octahedra and icosahedra.

Cherniss' criticism is attached to an earlier version of Mugler's thesis, published in *Platon et la recherche mathématique de son époque* (Strasbourg and Zurich, 1948) esp. 78-81 and 119. In this earlier work, Mugler's thesis is presented in a different, and even more vulnerable form. Mugler here quotes only the opening part of Plato's statement, the claim that there will be as many differences of size in the original triangles as there are differences of kind among the elements (57D1-3), and comments, p. 80:

'A l'infinie variété des espèces de matière que Platon admet avec Anaxagore correspond une infinie variété des grandeurs des polyèdres et par conséquent des deux espèces de triangles élémentaires qui les composent.'

The comment reveals all. Caught up, as so often elsewhere, in the fascination of his own ideas and of his own imaginings, and with that sublime indifference to the details of the text which too often characterises a certain type of Continental scholar, who sees himself as more a philosopher than an historian, more a 'man of letters' than a 'man of science', Mugler has simply taken for granted, as a result of a loose and wholly unwarranted conflation with the 'idées infinitistes' of Anaxagoras (cf. p. 138), that the differences of kind among the elements (cf. τὰν τοῖς εἶδεσι γένη, 57D3), and therefore the differences of size among the triangles, are infinite.

The misunderstanding of ἄπειρα is subsequent: Mugler's perverse reading of the sentence which follows in Plato's account (57D3-5) is simply his attempt to re-establish his earlier thesis in the face of Cherniss' criticism and of Cornford's *Cosmology* (which Mugler seems not to have read at the time of publishing his earlier work).

(iii)

And so to Popper. Popper states boldly (p. 528) that Cornford's thesis is 'quite unacceptable'. He explains the choice of half-squares and of half-equilaterals as the subelemental triangles by supposing that Plato deliberately wished to introduce into his system irrational numbers: $\sqrt{2}$ for the hypotenuse of the half-square (where the unit is the length of either of the remaining two sides); $\sqrt{3}$ for the longer of the two sides of the half-equilateral, adjacent to the right angle (where the unit is the shorter of the two sides). This employment of irrational numbers, or of their geometrical equivalents, would have been seen, according to Popper, as offering a practical solution to one of the major obstacles in the mathematical theory of Plato's day. Popper's objection to Cornford's theory is then that if Plato had aimed merely to arrive at subelemental triangles that were equal in size and the same in kind, he could have done so more easily without employing triangles which exhibited irrational

numbers, and therefore that Cornford's theory fails to explain the complexity of the procedure which Plato in fact employs for the construction of the geometrical figures.

Unfortunately, the recipe which Popper provides for arriving at equal subelemental triangles, without recourse to irrational numbers, proves to be unworkable. In the first published version of his note, *The open society* (Princeton, 1950) 528, Popper wrote as follows:

‘It would have been sufficient to divide into two the *sides* of the *Elementary Squares* and *Equilaterals* of what Cornford calls “Grade B,” building each of them up from four elementary triangles *which do not contain any irrationalities*.’

This construction will yield a division *ad infinitum* of equilateral triangles into further equilateral triangles, but fails to demonstrate the principle which Plato established at the outset of his construction of the regular solids, whereby ‘all triangles are derived from two triangles, each of which has one right angle and two acute angles’, namely a right-angled isosceles triangle and a right-angled scalene triangle (*cf.* 53C8-D4). The proposed construction will not work at all for the elemental squares, which cannot, as Popper claims here, be divided into four equal and ‘rational’ subelemental triangles.

Popper himself seems to have awoken to this deficiency in his argument, since in subsequent editions of his work (as listed in my Bibliography) he writes not of ‘triangles’ but of ‘figures’. The word ‘figures’ is sufficiently ambiguous to cover both squares and triangles, and Popper’s suggestion is now apparently that the elemental squares would be divided, not into triangles at all, but simply into smaller squares. But this of course is far less cogent as a criticism of Cornford’s interpretation, for at the beginning of his construction of the geometrical solids (53C4ff.) Plato states clearly that triangles are the simplest plane figures, and must therefore be taken as the starting-point of his demonstration. Plato, we may be fairly sure, would not have been interested in producing his elemental squares from smaller subelemental squares: the squares themselves must be produced from triangles.

It is in fact possible to construct a square from rational right-angled triangles, the same in kind and equal in size. But the simplest such division will require no less than 24 such triangles (obtained by dividing adjacent sides of the square into three parts and four parts respectively, constructing twelve rectangles from this division, and dividing these rectangles so as to obtain triangles whose sides are in the proportion 3:4:5). But this procedure is obviously more complicated than Plato’s division of the square into half-squares, and so does nothing to support Popper’s contention that if Plato had wanted to arrive at equal subelemental

triangles he could have done so more easily by avoiding triangles that were irrational.

I conclude that, on this more practical level, Popper's argument against Cornford is quite simply misconceived. Popper claims that Plato could have more easily divided the elemental squares and equilaterals into subelemental triangles, equal in size and the same in kind, which were not irrational. But this in fact is not so. For the principles which Plato has established at the beginning of his demonstration obviously require the four regular solids which will correspond to the four Empedoclean elements to be constructed ultimately from an original pair of right-angled triangles (53C4ff.). Popper's proposed construction of the solids fails to meet this requirement. His proposed division of the equilaterals fails to produce right-angled triangles, and his proposed division of the squares fails to produce triangles at all. If we seek to improve on Popper's argument, and to realise what was clearly Popper's original ambition, by constructing a square from triangles which are not irrational, then we can do so only by a construction obviously more complicated than the construction which Plato has in fact employed, and which requires the use of irrational triangles.

(iv)

Even apart from these practical inconsequentialities, Popper labours under a more radical, and more insidious, misconception, in the way in which he seeks to oppose Cornford's interpretation to his own.

Popper aims to prove that Plato could have arrived at equal subelemental triangles the same in size and equal in kind which were not irrational; he will then conclude that, since Plato employs triangles which are in fact irrational, he cannot at the same time have intended to exploit the divisibility of the triangles, in the way which Cornford's thesis requires.

But this form of argument needs only to be stated clearly for it to be apparent that neither one thesis need in fact exclude the other. Even if it can be shown that, in the *Timaeus*, Plato is likely to have had some special interest in irrational numbers, or their geometrical equivalents, it is nonetheless still perfectly possible that Plato will have intended the conclusion which Cornford suggests: namely that the subelemental triangles of the cubes and of the three transformable elements should be, for these two groups of polyhedra, both the same in kind and equal in size. For it is perfectly possible to suppose that Plato wanted to kill both birds with one stone: that he wanted to arrive at equal subelemental triangles, and that he also wanted to find a place in his scheme for the geometrical equivalents of irrational numbers.

This simple point has been obscured because of an assumption which is common both to Cornford's presentation of his thesis and to Popper's criticism of it.

In his derivation of the triangles, Plato is deliberately enigmatic. He makes great play of not telling us why, among the endless right-angled scalene triangles, the half-equilateral is 'best' (cf. 54A2-B2). The explanation, he tells us, would be 'too long' (λόγος πλείων, 54B1); and he invites the reader to find the reason for his choice (reading δὴ at 54B2) or the refutation of it (reading μή at 54B2). Modern commentators on the *Timaeus* have found Plato's challenge irresistible; and both Popper and Cornford present their respective theses as the answer to Plato's challenge (for Cornford, see esp. *Cosmology* 214).

Now the right-angled scalene triangle which Plato chooses as 'the best' (cf. 54A3), namely the half-equilateral, in fact has two properties in common with the isosceles right-angled triangle, or half-square. Both triangles are 'irrational', i.e. they possess one side which is incommensurable with the other two. And both triangles have the property of being divisible endlessly into smaller triangles which are the same in kind and (at each stage in the division) equal in size. Thus each half-square can be divided into two smaller half-squares (by bisecting the right angle); while each half-equilateral can be divided into either three or four smaller half-equilaterals in any one of a number of ways (by bisecting each of the angles of the complete equilateral, the construction which Plato will in fact employ at 54D7-E3; by tri-secting the right angle, and bisecting the largest of the resulting triangles; by dropping a perpendicular from the mid-point of the hypotenuse to the other two sides, and bisecting the resulting rectangle).

These two properties, 'irrationality' and this special kind of 'divisibility', are the explanations proposed respectively by Popper and by Cornford as the explanation of Plato's 'longer *logos*' (54B1). Popper claims that Plato has deliberately chosen to construct the four regular solids which will correspond to the four Empedoclean elements from triangles which exhibit irrationality. Cornford seizes on the companion feature of the half-squares and the half-equilaterals: the possibility of their endless division into triangles which are the same in kind and (at each stage of the division) equal in size.

And hence Popper's assumption that the student of the *Timaeus* must choose between Cornford's thesis and his own. Cornford, no less than Popper, has presented his thesis as the answer to the 'longer *logos*'. But Popper has not unnaturally assumed that there can be only one reason why the half-equilateral is 'best' (cf. 54A3), and therefore that if his own reason is right, then Cornford's is wrong.

But the sad truth is that as an exclusive answer to Plato's challenge neither Popper's thesis nor that of Cornford is particularly inviting, precisely because neither author succeeds in isolating a property which is peculiar to a half-equilateral. The half-equilateral is far from being the only right-angled scalene triangle which exhibits 'irrationality'. And any right-angled scalene triangle can be endlessly subdivided into triangles equal in size and the same in kind (by the third of the methods that I noted above, i.e. by dropping a perpendicular from the mid-point of the hypotenuse to the other two sides, and bisecting the resulting rectangle).

It is true that both properties belong to the half-equilateral in perhaps a rather special way. Many right-angled triangles are irrational, but the half-equilateral does of course have the advantage that in conjunction with the half-square it provides the first two irrational square roots ($\sqrt{2}$ and $\sqrt{3}$). Equally, the construction I have proposed for the division of any right-angled scalene triangle is not as simple or as elegant as the construction which Plato will in fact choose for the division of the half-equilateral (*cf.* 54D7-E3). For the division of the half-equilateral into three smaller half-equilaterals by the method Plato has in fact chosen (bisecting each of the angles of the whole equilateral, *cf.* 54D7-E3) is rather nicely parallel to the division adopted for the half-squares into two smaller half-squares (bisecting each of the angles of the whole square, *cf.* 55B3-C4); while the result of the two divisions has in common the feature that the subelemental half-equilaterals and half-squares join at a central 'pivotal' point on the face of each whole equilateral and on the face of each whole square. This is a feature which is not only pleasing in itself, but which Plato might have thought would facilitate the dissolution of the three transformable polyhedra and of the cubes into their constituent subelemental triangles, when the various elements attack one another (e.g. 56C8ff.): the triangular faces and the squares would fall apart, when attacked at the point of intersection.

But does either qualification make Popper's 'irrationality' or Cornford's 'divisibility' quite match up to the hopes aroused by Plato's promise of a 'longer *logos*' (54B1)?

Possibly. I prefer nonetheless, in arguing in favour of the thesis of smallest subelemental triangles, to abandon the assumption present both in Cornford's own presentation of this thesis, and in Popper's criticism of it: I have not presented Cornford's thesis as the answer to the 'longer *logos*'.

(v)

In the first two sections of this Note, I threw over Cornford's argument that equal subelemental triangles were needed to keep the differences of

size between the particles below the threshold of visibility. I have now discarded the claim that equal subelemental triangles were the secret of the 'longer *logos*' which Plato declines to give at 54B1. I would even prefer to abandon Cornford's suggestion that Plato has deliberately chosen to illustrate one of the intermediate grades of polyhedra, and that larger and smaller grades would have been arrived at by other methods of division (*Cosmology* 237-8; *cf.* p. 84 above). If Plato preferred the type of division that he has in fact chosen to describe (whether or not for the reasons I have suggested) then this may have been the *only* type of division which he employed for constructing *all* grades of polyhedra. The construction described (54D3ff.) would be, so to speak, a standard construction: any grade of half-equilateral (other than the smallest) would subdivide into smaller half-equilaterals by the same method (equivalent to bisecting the angles of the complete equilateral).

But by this point the reader may well ask: how much then is left of Cornford's original thesis? Does the rump deserve the name of Cornford?

Let me first try to dispose of, or at least to circumscribe, the problem of the 'longer *logos*' (54B1).

Very briefly, I resume the theory which precedes the construction of the geometrical solids (53C4ff.). Plato establishes, in quick succession, the following principles: all body contains depth (53C5-6); depth is bounded by surface (C6-7); rectilinear surface is constructed from triangles (C7-8); all triangles are derived from two <original> triangles, both of which have one right angle and two angles acute (C8-D2); one of these is a right-angled isosceles triangle (D2-3); the other is a right-angled scalene triangle (D3-4).

From these principles, Plato tells us, we must seek to derive the origin of the four elements, by identifying the four most beautiful bodies which will also be (or some of them) mutually transformable (53D4-E8; *cf.* ἄττα, E2). Plato therefore returns to the pair of original triangles. The right-angled isosceles triangle exists in only one kind (54A1-2). It is in fact a half-square and will be used later for the construction of the cube (55B3-C4). The varieties of right-angled scalene triangles are 'endless' (54A2). Plato chooses the half-equilateral (54A2-B5). From this there will be constructed the three regular solids made up from equilateral triangles, namely the tetrahedron, the octahedron and the icosahedron (54D3-55B3).

Plato's aim is clearly to present this theorising as both obvious (*cf.* 53C5) and necessary (*cf.* 53D5-6). For example, the claim that all triangles are derived from two original right-angled triangles is presumably based on the fact that any triangle at all can have a perpendicular drawn from at least one of its angles to the opposite side and will then yield one or other or both of these two triangles.

Hence the importance for Plato of the one feature in his demonstration which *prima facie* is arbitrary: the choice, from all the variety of right-angled scalene triangles, of the half-equilateral. And hence the prominence which Plato gives to the existence of a 'longer *logos*' (54A4-B2), which would provide the justification for his choice of triangle.

A well-known Cambridge preacher was regularly taken ill at the same point in the delivery of his favourite sermon. He recovered quickly, and took up his text, but with an obvious gap in the sequence of thought. No-one could ever reconstruct the argument which would have joined the two parts of the sermon.

Is Plato bluffing too? Plato fails to tell us why the half-equilateral is 'best'; but in practice he can hardly have chosen any other right-angled triangle if he is going to arrive at the correlation which his theory will require, and which he has already hinted at (53D4-E8), between the three transformable elements (fire, air and water) and the three regular solids whose faces are equilateral triangles. In its context, therefore, the purpose of the 'longer *logos*' is quite simply that it allows Plato, at this stage in his exposition (54A2ff.), to present the triangle which his cosmology will in fact require as resulting from some necessity antecedent to the construction of the geometrical solids.

What that necessity is, Plato has not told us. Is it too unworthy to suggest that Plato himself may not have known? At the very least, the reason why the half-equilateral is 'best' (except in so far as it leads to the construction of the regular polyhedra, and does so in a way which Plato may have regarded as peculiarly pleasing, or especially useful) is not essential to the continuation of Plato's theory. Plato has told us that, of all right-angled scalene triangles, the half-equilateral is 'best'; we, the reader, can continue to follow Plato's reasoning, content with the mere *fiat* of the author.

I conclude that the content of the 'longer *logos*' is something which Plato has deliberately chosen not to tell us; it is not therefore something which we can know for certain; I suspect that it may not be something which we even need to know.

(vi)

The advantage of discarding the problem of the 'longer *logos*' (even if only by treating it as insoluble) is that we are able to see more clearly a peculiarity and a problem which face us in the continuation of Plato's theory.

The peculiarity I have already noted (p. 84 above). When Plato arrives at the construction of the regular solids (54D3ff.), he introduces a com-

plexity for which nothing in the preceding analysis has prepared us. Plato uses six half-equilaterals instead of two for making up the equilateral triangle from which will be constructed the tetrahedron, the octahedron and icosahedron (54D3-55B3). And he uses four half-squares instead of two for making up the square faces of the cube (55B3-C4). Why, in each case, does Plato use more subelemental triangles than he apparently needs? Why the seemingly unnecessary refinement?

The problem. Plato's general intention, I have argued (pp. 159-65 above), is that the traditional belief in a cycle of change between the elements, alluded to at the beginning of the second part of the *Timaeus* (49B7ff.), should be placed on a new and so to speak scientific footing in Plato's account of the construction of the geometrical solids (53C4ff.). The subject is obviously one of pressing importance. Plato refers to the need for transformation in his initial statement of principle (53E2); he explains how the traditional belief can be satisfied by his choice of elemental triangles (54B5-D3; cf. p. 165 n. 40 above); he returns to the subject in detail as soon as he has established the correlation of the regular solids with the elements (56C8-57C6); and again after his statement that the original triangles differ in size (58A4-C4; differences of size, 57C7-D7). But therein lies the problem: how can we continue to believe in a transformation of the elements (58A4-C4), once we have been told that the original subelemental triangles, the half-square and the half-equilateral, differ in size (57C7-D7)? Is transformation then possible only between particles which are made from triangles which are all of the same grade?

This was not at all the impression that Plato had given. It would be possible perhaps, retrospectively, to read Plato's repeated accounts of transformation (53E2; 54B5-D3; 56C8-57C6; cf. 58A4-C4) as though they implied a barrier not only between earth and the other elements, but no less between each of the different grades of earth and between all the different grades of fire, air and water, so that transformation would be possible only between the equivalent grade of any one of the three transformable elements. But it is certainly much simpler, conceptually, to read all these accounts as though any one portion of earth could be transformed into any other, and as though any one portion of air could be transformed into any one portion of fire or of water.

And if we take account of the 'peculiarity' of Plato's theory (54D3ff.), this is exactly what we can do. 'Total' transformation will be possible, if the process of division which Plato has in fact employed in the construction of the elemental equilateral triangles (54D5-55B3) and of the elemental squares (55B3-C4) is continued, so that the half-equilaterals and half-squares are made up from many more subelemental triangles,

which will be ultimately not only the same in kind (half-squares or half-equilaterals) but also equal in size.

This therefore is the only context and the only purpose for which I would wish to defend the thesis which I am perhaps over-scrupulous in continuing to attach to the name of Cornford. Plato has chosen to construct the four regular solids corresponding to the four Empedoclean elements from a division of the elemental squares and the elemental equilaterals into half-squares and half-equilaterals, both of which figures can be endlessly sub-divided into triangles which are the same in kind and (at each stage of the division) equal in size. My thesis is that Plato intended to carry this process of division to a stage which would yield equal subelemental triangles for all grades of the elemental squares and for all grades of the elemental equilaterals. Once Plato had carried the division this far, there would be no point in taking it farther (*pace* Mugler). We should have arrived at a theory of smallest subelemental triangles: half-squares and half-equilaterals.

Only if there does exist such a division of the subelemental half-squares and of the subelemental half-equilaterals will it be possible in fact for transformations to take place between any one particle of earth and another, as well as between any and every particle of fire, air and water, which is certainly the simplest way, conceptually, of reading the several accounts which Plato has provided of the transformation of the elements.

(vii)

Admittedly, conceptual simplicity is an uncertain guide to the interpretation of the *Timaeus*. Hence the importance of the argument that I have added to Cornford's defence of his hypothesis (pp. 85-7 above), namely that this conclusion was shared by Aristotle. This point has not only escaped Cornford himself; it seems to have been overlooked both by his admirers (e.g. Guthrie, *History* v 288-9) and by his critics. There are, it is true, two possible objections to the use I have made of Aristotle's evidence; these I shall now briefly review.

Perhaps the most pressing objection is that Aristotle's initial specification of 'equal parts' (*De caelo* iv 2, 308b9) is not attached directly to the theory of the *Timaeus*, but is intended as Aristotle's own observation, prior to his statement of the theory of the *Timaeus*. Thus in the passage in question (*De caelo* iv 2, 308b3ff.), Aristotle first states that a body is heavier or lighter if it is made from a larger or a smaller number of like parts, in the way that a larger quantity of lead or copper is heavier than a smaller quantity (308b3-9). Aristotle then applies this same rule to the comparison between different substances, wood and lead (308b9-12). I

have taken both assertions as representing Plato's theory; John L. Stocks apparently takes the passage to mean that the second comparison, the comparison between *different* elements, is alone attributed directly to Plato (308b9-12), while the comparison of different quantities of the *same* element, with the specification of 'equal parts' (308b3-9), has been introduced by Aristotle himself, by way of a preliminary explanation of Plato's theory. (This at least I take to be the implication of Stocks' rendering and of his note, in the Oxford translation *ad loc.*; whether this conclusion was actually intended by Stocks is not altogether clear.)

But Stocks' interpretation will not bear scrutiny. It is true that Aristotle would agree with the common-sense verdict that a larger quantity of lead or of copper is heavier than a smaller quantity (308b5-8), but in Aristotle's text this assertion is generalised to include 'every other substance made of parts that are of like kind' (τῶν ἄλλων τῶν ὁμοειδῶν ἕκαστον, 308b8), and it is to this generalised statement of the comparison between different quantities of the same element or of the same substance that there is attached the expression 'because of the preponderance of equal parts' (ἐν ὑπεροχῇ γὰρ τῶν ἴσων μορίων βαρύτερον ἕκαστόν ἐστιν, 308b9). This generalised statement of the comparison cannot belong to Aristotle, as Stocks seems to think it should, for Aristotle does not believe that the more there is of *any* body the heavier it will be. This is indeed precisely the point which Aristotle seizes upon in order to refute Plato's theory: the more fire there is, the *lighter* it will be (308b15ff.).

Stocks has perhaps been influenced by the consideration that in Plato's initial statement of weight as defined by number (56Aff.) the comparison does lie between different elements (fire is the 'lightest' of the three transformable elements), and that the comparison between different quantities of the same element is peculiar to the later theory, of weight as defined by resistance (62C3ff.). But justification for the comparison of different quantities of the same (or nearly the same) element may be found, even in the earlier theory, in Plato's comparison of copper and gold, substances which are made from 'nearly' the same primary particles (59B6-C3: for this comparison, see above pp. 89-96).

My conclusion does not mean of course that the passage in the *De caelo* is wholly free from the influence of Aristotle's own ideas. For example, despite φασι (308b10), the motive for Aristotle's choice of wood and lead to illustrate the comparison between different elements is, I suspect, simply that he selects the example which he will later use in explaining his own theory (*De caelo* iv 4, 311b1-13, a passage which I examine in detail in my third volume).

But this does not affect the main burden of the passage: Aristotle clearly intends to attribute to 'the written theory of the *Timaeus*' (cf. 308b4-5)

both the comparison between different elements and no less the comparison between different quantities of the same element. From this it will follow that Aristotle means to attribute to Plato a theory where weight is defined by the number of 'equal parts' (308b9, *cf.* 308b34), elsewhere specified as 'surfaces' and as 'triangles' (references, p. 85 above).

(viii)

My use of Aristotle's evidence may however be attacked from a different direction. Thus I have already acknowledged that in the passage where fire is 'lightest' because it is made from 'the smallest number of like parts' (56B1-2), the 'parts' are clearly intended to be triangles that are both the same in kind (half-equilaterals) and, for each of the three transformable elements, equal in size (*cf.* pp. 81-2 above). In glossing this passage, why should Aristotle have had in mind the later passage where the original triangles are said to be of more than one size (57C7ff.)? And yet unless Aristotle has in mind this later passage, his evidence does nothing to confirm the belief that even the triangles which differ in size are ultimately made up from triangles which are the same in size. Might Aristotle not intend to paraphrase the earlier and simpler statement of Plato's theory (56B1-2), with no thought for the difficulty produced by the later passage?

To go one step further: it may be claimed that Aristotle knew *only* of triangles that were equal in size, and that he had no knowledge of triangles that differed in size. And in that case the remarks I have quoted from Aristotle (pp. 85-6 above) cannot be taken as evidence that Aristotle's equal triangles were thought of by him as being the ultimate constituents of the triangles that for Plato differed in size.

It seems to me in fact rather unlikely that Aristotle should have taken account only of Plato's initial construction of the geometrical solids (53C4ff.), and that he should have failed to notice the passage a page or two later (57C7ff.), where Plato states explicitly that the original triangles differed in size. In my argument so far I have taken it for granted therefore that Aristotle was aware of the differences in size that mark the triangles, and I have used his evidence as confirmation of the complementary feature of the theory: that triangles of different size are ultimately made up of triangles that are all the same size.

Indeed I dwell on the point now, principally because Moraux has taken the opposite view. He supposes that Aristotle will *not* have reckoned with triangles that *differ* in size. He writes, *De caelo* Budé edn cxlvii:

'Ce perfectionnement de la théorie', i.e. different sizes of triangles for different varieties of each element, 'paraît avoir échappé au Stagiritte, car s'il y

avait pris garde, il aurait monté en épingle les difficultés qu'elle entraîne et n'aurait pas manqué de dénoncer l'incohérence de l'explication proposée par Platon.'

Not only is this in itself implausible, it seems to me; it is in any case contradicted by a passage at the end of book three of the *De caelo*, where Aristotle does in fact direct his criticism against a theory of 'unequal pyramids' for different types of fire.

Aristotle first envisages a theory where heat is explained by the shape of the primary particles, whether spheres or 'pyramids' (i.e. tetrahedra, iii 8, 306b29ff.). He complains that this theory can make no provision for explaining cold on the same principles, 'since there is no opposite to shape' (307b5-10). Some of the proponents of this theory are therefore led into contradiction, since in fact they explain cooling, not by shape, but by size: larger-sized particles cause compression and are unable to pass through the pores of the body they have attacked (b10-13). Aristotle concludes that if large-sized particles cause cooling, then small-sized particles should be associated with heat, and that in that case hot and cold are defined in practice not by differences of shape but by differences of size (b13-16). This leads to a further and final contradiction: if the pyramids differ in size (εἰ ἄνισοι αἱ πυραμίδες), then the large pyramids can no longer be counted as fire (b16-18).—For it is size and not shape which has in practice been adopted as the explanation of differences in temperature, and larger-sized particles have been taken as the explanation of cooling, and not of heat.

Plato is not named in this passage. But not only is the identification of fire with 'pyramids' the theory of the *Timaeus*; the explanation which Aristotle quotes for cooling, the compression caused by larger-sized particles (307b11-13), corresponds closely to the explanation given in the *Timaeus* (61D5-62B6, cf. 58D8-59A8 and 59D4-E5; see pp. 113-15 above). There can be little doubt that Plato is in fact the target of Aristotle's criticisms here, as he has also been in the pages of the *De caelo* immediately preceding (iii 7, 306a1ff.).

To return to Moraux's problem: if the pyramids which make up fire are 'unequal' (εἰ ἄνισοι αἱ πυραμίδες, 307b16-17), then the triangles which correspond to the faces of the pyramids must be unequal also; and so too therefore will be the 'original' half-equilateral triangles from which each face is made. This therefore is precisely the passage that Moraux is looking for, and has strangely failed to find, where Aristotle 'monte en épingle' the refinement of the theory of the *Timaeus*, whereby there are different sizes of triangles for the different varieties of each element, and 'dénonce l'incohérence de l'explication proposée par Platon'.

(ix)

I return therefore to the general plausibility or otherwise of the thesis which I have perhaps too scrupulously dignified with the name of Cornford.

When Plato first defines the tetrahedron which will correspond to fire as the 'lightest' body because it is 'composed of the smallest number of like parts' (56B1-2), his formula is (deliberately?) ambiguous.

It is not ambiguous in its initial context. When Plato first writes of the construction of the geometrical solids (54D3ff.) and then of the various characteristics that belong to them (size, 'sharpness', mobility, weight, 55D6ff.), his reader would have no reason to suppose that he was intended to compare solids which were of more than one 'grade'. Indeed it is only if we do think of a single size of triangular face for each of the three transformable polyhedra that it will be obvious that the tetrahedron is, as Plato claims it is, the 'smallest' body (56A3-4), and the body therefore with both 'the fewest faces' (56A6-7) and 'the smallest number of like parts' (56B1-2; for my distinction between 'faces' and 'parts', see p. 81 above).

It is only in retrospect that we see the ambiguity in Plato's formula. For when we are told that the original triangles, the half-square and the half-equilateral, differ in size (57C7ff.), then (adopting the distinction I have proposed between 'parts' and 'faces') it will still be true that the tetrahedron has 'the fewest faces' of the three transformable polyhedra, but it will no longer necessarily be true that the tetrahedron has 'the smallest number of like parts'. For if these 'parts' are construed as the 'original' half-squares or half-equilaterals, then, according to Plato's present analysis (57C7ff.), these parts are no longer 'the same'. They are of course still the same in kind: half-squares or half-equilaterals. But they are no longer 'the same', or equal, in size, for the three transformable polyhedra, nor even for the different grades of any one polyhedron.

Plato's original formula can however be given a new lease of life, if we suppose that the triangular faces of polyhedra which differ in size are made up ultimately from a single smallest size of half-equilateral triangle which will therefore, in this new and more sophisticated sense, be 'the same' for any and every grade of the three transformable polyhedra (with smallest half-squares for all grades of cube). And in retrospect we see that the possibility of just such a division is allowed for by the construction that Plato has in fact employed in his initial account of the formation of the geometrical solids (54D3ff.).

Hence too the ambiguity in Aristotle's evidence. Plato employs his formula for weight (56B1-2) prior to the announcement of differences of size

(57C7ff.). Aristotle uses the same formula as a general description of Plato's theory, and indeed specifies that the comparison of weight lies between parts which are not merely 'the same' but 'equal' (references pp. 85-6 above). If Plato had said as much, subsequently to his introduction of differences of size, the implication would have been pretty obviously that he did mean to exploit the feature allowed for in his initial construction of the regular solids. Is the implication any the less obvious on Aristotle's evidence?

(x)

Who can tell? We are dealing only with possibilities. It is possible that Aristotle failed to note the inconsistency whereby the definition of weight by 'equal triangles' would no longer be true for the comparison between substances made from triangles which differed in size. It is possible that Plato himself was not alive to this inconsistency, or intended the definition of weight by number to be true only for the comparison between substances made all from the same grade of triangle.

It is possible, but hardly probable. Aristotle gives no sign that he has taken Plato's theory in this restricted sense; indeed rather the contrary. If Plato's theory had been inconsistent, then it is odd that Aristotle should not have noticed the point, and taxed Plato with it.

Aristotle's failure to exploit the inconsistency, I suspect is evidence that the inconsistency did not exist.

My conclusion is not that Plato necessarily and inevitably thought of the different grades of geometrical solids as being composed ultimately of subelemental triangles equal in size and the same in kind (subject of course to the difference between half-squares and half-equilaterals), but simply that this is a plausible and persuasive reading of the theory of the *Timaeus*, and that Plato may well have intended his readers to draw the conclusion that seems in fact to have been drawn by Aristotle.

VOID

I turn therefore to the second major point in the reconstruction I have adopted of Plato's geometrical theory and its application to the cosmos: the apparent inconsistency in Plato's both denying and accepting the existence of void (*cf.* pp. 88-9 and p. 168 above).

In the account he gives of movement and rest subsequently to the construction of the geometrical solids (57D7ff.), Plato first plainly denies the existence of void: the revolution of the whole 'does not allow any empty space to be left' within the cosmos (κενήν χώραν οὐδεμίαν ἐᾷ λείπεσθαι, 58A7). He then no less plainly refers to the existence of 'emptiness' (κενότης, 58B3) or of 'gaps' (διάκενα, B5) between the elements.

No doubt Plato is capable of passing inconsistencies, but this can hardly be the explanation of the present passage. For not only does the denial of void reappear both in Plato's account of the 'solidification' of metals (59A1-2) and repeatedly in his account of breathing (79B1, B3, C1; see also 80C3); more significantly, in the account of stones, both features recur: the denial of void (60C1-2) and then, four times in succession, the existence of 'gaps' (διάκενα, 60E5, 61A1, B1, B4).

(i)

Taylor and Cornford both decide that Plato has to be consistent, and therefore agree that he must be made to eat his words at 58A7. This is achieved by giving the verb in the sentence I have quoted (ἐᾷ, 58A7) an inceptive force. Thus instead of the simple denial of empty space, we have merely an attempt to prevent the existence of empty space. Taylor translates rather coyly, 'is fain to leave no empty space' (tr. p. 58; *cf.* *Commentary* 399). Cornford, more boldly, and more awkwardly, puts in both meanings, 'allows (*or tends to allow*)' (*Cosmology* 242), adding in his commentary that '*so far as possible*, no vacant interstices will be left within the sphere' (244-5, my italics).

Cherniss takes just the opposite approach. Taylor and Cornford have tried to draw the sting from Plato's denial of empty space; Cherniss attempts to undo Plato's admission, in this same passage (57D7ff.), that there are gaps or interstices between the elements. He writes, *ACPl* 154:

'Plato ... apparently thought that the interstices between the corpuscles could be completely filled up because the variations in the size of the

triangles of any one class would provide corpuscles of so many sizes as to make the number of arrangements practically unlimited.'

There are two questions at stake here: whether in fact it is possible to pack Plato's polyhedra so as to have no gaps between them; and whether Plato himself thought that this was so.

I take first the question of fact. Bruins explores the mathematical niceties, *RMM* 56 (1951) esp. 271-2. He tells us that of Plato's polyhedra only the cubes can be packed together so as to have no gaps between them; and in particular he corrects the assumption in Taylor, *Commentary* 399, 405, 409, and in Cherniss, *ACPl* 154, that this is true also of tetrahedra. The combination of particles of different shapes and of different sizes obviously opens up more possibilities; but Bruins' calculations inform us that no particle, however small, could entirely fill the gaps left within groups of icosahedra. (The dihedral angle between two icosahedra with a common face is too small for any of the other polyhedra to enter, with the exception of the tetrahedron; and the tetrahedron would leave a gap of some 13°.)

More important still, there is no indication that Plato himself thought that the gaps between the particles 'could be completely filled up' (Cherniss, *ACPl* 154). In the passage in question, Plato does tell us that small particles are forced to enter the gaps between large particles (58B4-5). But he does not then tell us that the result will be to 'fill up the gaps completely'. Quite the contrary, he tells us that the smaller particles will be forced to join together by the larger particles, and that the larger particles will be cut to pieces by the smaller particles (58B6-7), and that by this means the process of change in the cosmos will continue endlessly (58B8-C4). Plato's purpose here is to demonstrate the endless continuity of change, and the existence of 'gaps' between the particles is essential to this purpose. For if there were to be any permanent alteration in the condition of the cosmos, such as the disappearance of 'gaps' between the particles, then the process which Plato has described would no longer continue, and Plato's purpose—change without end—would be frustrated.

Taylor and Cornford have attempted to whittle away the denial of empty space. Cherniss attempts to undo the assertion that there are gaps. Both approaches seem to me only to mask the problem: I believe that we should maintain both Plato's denial of empty space, and his assertion of 'gaps' between the elements.

Plato's meaning I take to be that there are no permanent pockets, no large tracts, of empty space anywhere within the universe. But at the same time Plato will not have meant to deny the obvious: namely that some at least of the different-sized and different-shaped particles will necessarily have 'gaps' between them.

(ii)

However, to see both points in perspective, and in particular to see why Plato should need to state both points together, we need to go back to undo the assumption which has prevented both Taylor and Cornford from understanding the beginning of the sentence I first quoted. In denying the existence of empty space, Plato writes as follows, 58A4-7: ἡ τοῦ παντὸς περίοδος, ἐπειδὴ συμπεριέλαβεν τὰ γένη, κυκλοτερὴς οὔσα καὶ πρὸς αὐτὴν πεφυκυῖα βούλεσθαι συνιέναι, σφίγγει πάντα καὶ κενὴν χώραν οὐδεμίαν ἐᾷ λείπεσθαι.

Taylor obviously changed his mind in the course of compiling his notes on this passage. In the main part of his *Commentary*, 398-9, *cf.* 386-7, he is adamant that a simple circular motion does not in fact create any centripetal pressure, and that Plato must therefore be prevented from saying that it did. He therefore translates σφίγγει (LSJ, *s.v.* 'bind tight, bind fast ... press together') as 'encompasses round about' (*Commentary* 398; tr. p. 58, 'clips them all round'), with no notion, here or later in the passage (*cf.* *Commentary* 400), either of circular motion or of constriction. And yet at the beginning of his discussion Taylor had himself translated with the much more obvious sense, 'squeezes them all tight' (*Commentary* 397), while at the end of his discussion (*Commentary* 398) he specifically gives his blessing to Martin's 'resserre' (*Études* i 157, mis-spelt by Taylor as 'reserre'), a word which can happily be translated by 'squeeze' in English.

Very oddly, Cornford is inconsistent in just the same way. He tells us that Taylor is right in excluding the notion of 'a constricting force' (*Cosmology* 243), and in the continuation of his commentary (pp. 243-6) he clearly wants to restrict the sentence to describing circular movement without constriction or compression; and yet the translation he had himself given on the preceding page (*Cosmology* 242) is: 'constricts'.

This shilly-shallying seems to me all very unnecessary. In the sentence quoted (58A4-7), Plato tells us specifically that 'the revolution of the whole' has a tendency to 'turn in upon itself'. It therefore seems to me quite artificial to suppose that σφίγγει has here any other than its usual meaning of 'binding tight', 'squeezing', 'pressing' (*cf.* LSJ, *s.v.*). I also find it difficult not to see the idea of περίοδος ... σφίγγει picked up in ἡ ... τῆς πιλήσεως σύνοδος ... συνωθεῖ (58B4-5), and I have summarised the whole passage accordingly (pp. 88-9 above). The sentence quoted above (58A4-7), I would therefore paraphrase as follows:

'Once the circuit of the whole has drawn together and enclosed within itself the *gene* <i.e. the geometrical solids corresponding to the four Empedoclean elements>, then since it is circular in shape, and since it is

endowed by nature with a tendency to close in upon itself, it squeezes all <the *gene* that are enclosed within it> and stops any empty space being left.'

Why Plato should have thought that a circular motion would exert a constricting force is of course a different question. The answer, if there is one, would have to begin with a study of several earlier philosophical fragments (notably σφύγγων in Empedocles, fr. 38.4). But all that I leave aside here. Whatever the earlier history of the question, it seems to me indubitable that, once we have freed Plato's text from any ideas of our own on the mechanics of compression, then Plato does here clearly suppose that the circular movement of the whole exercises a constrictive pressure on the particles contained within the cosmos.

Once we have admitted the notion of force or of constriction, then Plato's remarks on void become susceptible of a reasonably coherent construction. It is the compression exerted by the revolution of the whole which acts to prevent the existence of any large tracts or pockets of empty space, since the pressure of the whole forces the geometrical solids to crowd in upon one another. But denial of 'empty space' in this sense does not prevent the existence of gaps between the particles, if only because it would not in fact be possible to fit together the different shapes and different sizes of Plato's particles so as to leave no space between them.

Seen in this way, the two features of Plato's explanation, far from being inconsistent, are in fact complementary. The pressure from the revolution of the whole acts to prevent the formation of any permanent pockets, or larger tracts, of empty space (cf. 58A7). Therefore when the elements are driven in upon each other the smaller particles are forced to enter the gaps between the larger ones (cf. 58B4-5). They cannot do otherwise, precisely because there are no larger tracts of empty space where the particles could retreat to, in order to escape from the pressure of the whole. And yet this constant interpenetration of the elements does not prevent the existence of 'gaps' between the particles. The particles could not in fact be packed so closely as to have no gaps between them; and the existence of such gaps is in any case essential to the process by which change in the cosmos continues endlessly (cf. 58C2-4).

(iii)

This explanation of Plato's 'denial' of void in the account of movement and rest which accompanies the construction of the geometrical solids (57D7ff.) clarifies Plato's intention in the remaining passages I have noted. In each case, Plato's concern is with the transmission of movement or 'thrust' from one group of particles to another, and the denial of void is invariably included as a necessary condition of this process.

Thus when metals are cooled, the fire which had been inside the metal escapes. The fire cannot 'depart into a void' (*cf.* ἄτε οὐκ εἰς κενὸν ἐξιώντος, 59A1-2), and it therefore presses upon the surrounding air. The air in turn presses upon the metal. The metal, which is still in a fluid state, is forced to re-enter the places which had been occupied by the fire. It therefore recovers its former uniformity and solidifies. (The whole process, 59A1-8: note esp. ὠθούμενος, συνωθῶν, συνωθούμενος.)

A similar process determines the formation of stones. Water that had been mixed with earth turns into air and escapes. There is no empty space above the earth and air (*cf.* κενὸν δ' ὑπερεῖχεν αὐτῶν οὐδέν, 60C1-2). Therefore the air which escapes exerts pressure on the neighbouring air (just as fire had done in the formation of metals). The neighbouring air in turn squeezes together the earth, and forces it to enter the places that had been occupied by the water. The earth therefore is compressed and turns into stones. (The whole process, 60B6-C7: note esp. ὠσθεῖς, ἔθλιψεν, συνέωσεν, συνωσθεῖσα.)

Plato's account of breathing begins boldly: 'Since there is no void into which any moving body can make its way ...' (ἐπειδὴ κενὸν οὐδέν ἐστιν εἰς ὃ τῶν φερομένων δύναιτ' ἄν εἰσελθεῖν τι ..., 79B1-2). The principle then employed is that air which leaves the body must therefore displace the surrounding air, and this in turn pushes the air which is next to it, until air from outside the body enters and takes up the places that had been occupied by the air which has left the body (79B2-C1). We are twice told that this process is inevitable 'because there is no void' (B3, C1). The result of this process is that as one current of air leaves the body by the mouth or nostrils it forces air from outside the body to enter by the lungs and chest; while a second current of air, which leaves from the lungs and chest, forces air from outside the body to enter by the mouth and nostrils (79C2-7: note esp. ὠθεῖ and ὠθούμενον, 79B4; περιωθεῖ, C6).

Finally, in a kind of appendix to the account of breathing, Plato notes that rivers, thunderbolts and magnets are explained by the same mechanism: 'circular thrust' (*cf.* περιωθεῖν), dependent upon the absence of void (80B8-C8).

I have troubled to rehearse these four additional passages where Plato denies the existence of void (metals, 59A1-8; stones, 60B6-C7; breathing, 79B1-C7; rivers etc., 80B8-C8), hoping to bring home just how meaningless it is simply to string together a series of references where Plato allegedly 'assumed that the universe is a plenum' (Cherniss, *ACPI* 154) or 'was quite blunt that there was no void' (Claghorn, *Aristotle's criticism of Plato's 'Timaeus'* 14). For not only do these claims obscure the point that in his account of stones (60B6-61C2), as in his general account of movement and rest (58A4-C4), Plato does explicitly allow the existence of

'gaps' or 'emptiness' between the particles, in almost the same breath in which he denies the existence of empty space (60C1-2, 58A7); even more seriously, the authors I have quoted apparently fail to appreciate, or at least conceal from their readers, the crucial point that Plato's denial of void is obviously itself heavily dependent upon its context.

For in all cases where Plato denies the existence of void, he does so in order to establish the necessity whereby movement of any one group of particles exerts pressure on the neighbouring particles. The void which Plato denies, one can reasonably assume, is a void which would prevent this happening: some large stretch of empty space where the pressure exerted by one particle on a neighbouring particle would be lost. The existence of 'gaps', which would in any case be inevitable between some at least of the particles, but which would not be large enough to keep the particles from touching one another, or at least from transferring pressure from one particle or from one group of particles to another, is irrelevant to this mechanism, and on Plato's own admission the existence of such 'gaps' is not in fact excluded by the 'denial' of void.

(iv)

Here, as so often, the modern interpretation of the *Timaeus* has been unable to escape from the shadow of Plato's all too powerful pupil. The sentences I have quoted from Cherniss and from Claghorn echo the judgement of Aristotle. In the *De generatione et corruptione* Aristotle states plainly: 'Plato says that there is no void' (i 8, 325b33). There is the same claim, but indirectly, in the *De caelo*, where Plato (or so I shall argue in my third volume) is included among those who are said to deny the existence of void (iv 2, 309a21).

But it is essential to note that in both passages the contrast lies with the Atomists. Clearly Plato did deny the existence of void in the sense in which the Atomists asserted it: for clearly in the Atomist universe the atoms are not, or not always, so closely packed as to be unable to escape from contact with each other. (See, for example, the allusion to a 'great void' in the Atomist cosmogony related at length in Diogenes Laertius, ix 31 = DK 67A1, paraphrased in my first volume, p. 205.)

But does it then follow, as Claghorn and Cherniss have assumed, that Plato will have denied the existence of void in the same sense in which Aristotle will do?

Aristotle's denial of void (*Phys.* iv 6-9) is tied both to his theory of 'place' and to his non-granular conception of matter. It is a denial which totally excludes the existence of empty space, quite independently of any question of size. The theory of elemental particles in the *Timaeus* would

have barred the way to such a total denial, even if Plato had wished to make it.

Instead, I would suggest, Plato's denial of void, throughout the *Timaeus*, is concerned solely to ensure the necessity of transmitted pressure, both in the cosmos at large, and in the explanation of particular phenomena: the solidification of metals, the formation of stones, breathing, the magnet.

Once Plato's denial of void has been related to this context, then not only is it seen to be compatible with the existence of gaps or interstices between the particles. More importantly, the falsity of the assimilation to Aristotle's theory is plain: Aristotle's denial of void is strategic and ideological; Plato's is merely tactical and functional.

'COPPER AND GOLD' (TIM. 59B6-C3)

τὸ δ' ἐγγὺς μὲν χρυσοῦ τῶν μερῶν, εἶδη δὲ πλείονα ἐνὸς ἔχον, πυκνότητι δέ, τῇ μὲν χρυσοῦ πυκνότερον ὄν, καὶ γῆς μόριον ὀλίγον καὶ λεπτὸν μετασχόν, ὥστε σκληρότερον εἶναι, τῷ δὲ μεγάλα ἐντὸς αὐτοῦ διαλείμματα ἔχειν κουφότερον, τῶν λαμπρῶν πηκτῶν τε ἐν γένος ὑδάτων χαλκὸς συσταθεὶς γέγονεν.

I have occupied myself, so far, exclusively with Cornford's interpretation of this tricky passage (pp. 89-96 above). Although his explanation seems to me unsatisfactory, Cornford does at least face the problem squarely. The same is scarcely true of other commentators.

Martin, for example, hardly does more than re-state the problem when he writes of Plato, *Études* ii 260:

'Pour apprécier la densité, il considère la matière de l'airain, indépendamment des vides qui se trouvent dans sa masse, ... pour apprécier la pesanteur, il considère le poids de la masse poreuse sous un volume donné.'

Martin's interpretation is ham-strung by his adopting the reading of mss. F and Y (recorded by Burnet as) *πυκνότητι μὲν χρυσοῦ πυκνότερον*, instead of the reading of ms. A, rightly adopted by Burnet, and transcribed above (*πυκνότητι δέ, τῇ μὲν χρυσοῦ πυκνότερον*). On Martin's reading, there is no 'bifurcation' of the conception of density between hardness and weight. Instead, 'density' is attached exclusively to the question of hardness. Hence Martin's comment that Plato has simply ignored the presence of interstices between the icosahedra, when considering the 'density' and the 'hardness' of copper.

Later writers have been unable to free themselves from the influence of Martin's commentary. For example, Taylor adopts the text in Burnet, but is content to repeat the 'explanation' that Martin had given, *Commentary* 417:

'Timaeus, in estimating density, takes into account only the volumes filled by the actual particles of a body and leaves the *διάκενα* between them out of his reckoning.'

Characteristically, Taylor follows this with a whole series of remarks on 'comparative densities' and 'the fundamental principle of hydrostatics' discovered by Archimedes, all designed, apparently, to explain 'how Timaeus can make statements about densities which strike us as glaring errors'. But although it is true, as I have suggested, that Plato's perspective, on the relation of weight and density may differ significantly from our own (*cf.* pp. 93-5 above), it is surely no explanation of the present

passage simply to claim that 'in estimating density' Plato, or Timaeus, 'leaves the διάκενα ... out of his reckoning'. (Plato in fact writes, not of διάκενα but of διαλείμματα, 59C1.)

The truth is that, although he has adopted Burnet's text, Taylor has not understood it. The implication in τῇ μέν Taylor takes to be that copper 'would be "denser than gold, but not so dense as adamant"' (*Commentary* 417). But the expression which in Burnet's text answers to τῇ μέν is not a comparison, unexpressed, with *adamas*, but the clause introduced by τῷ δέ. 'In respect of density' (πυκνότητι δέ), copper is denser than gold 'in one way' (τῇ μέν), namely in containing, in addition to the icosahedra of water, the square surfaces of earth; 'on the other hand (τῷ δέ ...), in virtue of having large interstices within it, it is lighter.' It is true that, in Plato's sentence, there is a lack of formal symmetry, since τῇ μέν is not answered by τῇ δέ, and in this sense therefore Plato 'leaves his statement formally unfinished, as educated men continually do' (Taylor, *ibid.*), but it is not true that the μέν is therefore without any answering δέ.

Taylor has misunderstood Plato's sentence, not simply because he has failed to understand Plato's language, but because he has failed to appreciate the rôle of earth in Plato's theory. Taylor writes explicitly that:

'The earth is only introduced into the composition to account for ἰός by the theory that it is earth which has worked to the surface of the metal' (*Commentary* 417).

It is true that earth will be used by Plato to explain the presence of verdigris (59C3-5). But its more immediate and more obvious purpose (obvious—*cf.* ὥστε, B8) is clearly to explain how, in virtue of its square surfaces, the presence of earth can make copper 'harder', and in that sense 'denser' than gold, without adding proportionately to its weight. (Note the two causes of hardness, 62B8-C3, quoted p. 91 above.)

It is characteristic that Taylor should have failed to see this point, while launching with his inimitable self-assurance and dogmatism into a whole series of purely imaginary details:

'The earth is said to be scanty, to explain why there is not a thicker coating of ἰός on copper or brass which has been exposed to the air. And ἰός is only mentioned at all because one of the peculiarities of gold is that it does not "rust". Strictly the earth is regarded as no part of the metal; it is a foreign substance which works its way to the outside and so becomes visible "in process of time". It is presumably said to be "earth" from a supposed resemblance to vegetable mould.'

These details are purely fictitious. There is nothing in the text to justify the comparison with vegetable mould, or Plato's preoccupation with the fact that gold does not rust, or the idea that earth is not 'strictly' a part of copper (Plato does not say that *all* the earth in copper turns to verdigris).

Even the claim that Plato means 'to explain why there is not a thicker coating of ἰός on copper or brass' is just one more bright idea, which has no necessary connection with Plato's text at all. The reason why earth should be 'scanty' is more simply, and sufficiently, explained by Plato's assertion that copper is in general 'close' to gold (59B6). The differences—the ingredients peculiar to copper—must therefore obviously not outweigh the similarities.

Subsequent commentaries have done little to advance the understanding of Plato's text. Halleux, *Le problème des métaux dans la science antique*, transcribes Burnet's text (p. 89), but, like Taylor, he is content to repeat Martin's explanation (p. 93), and indeed his translation (pp. 89-90) appears to correspond, not to the text he has transcribed, but to the text he has read in Martin. Thus 'd'une densité plus grande que celle de l'or' has to do service for πυκνότητι δέ, τῇ μὲν χρυσοῦ πυκνότερον, and looks suspiciously as though it has been designed to translate πυκνότητι μὲν χρυσοῦ πυκνότερον (mss. F and Y, adopted by Martin). Halleux's mistranslation totally obscures the point that, in Burnet's text, πυκνότητι δέ serves to introduce not only τῇ μὲν ... πυκνότερον, but also τῷ δέ ... κουφότερον. (Halleux also writes ἔχων for ἔχον at 59B6; this is presumably a simple error of transcription.)

THE 'PATHOS' OF WEIGHT

(i)

To clarify my discussion, I have sought to provide a simple opposition between an 'objective' and a 'subjective' interpretation of *pathemata*, attached respectively to the names of Taylor and Cornford (ch. VII, pp. 124ff. above). This perhaps does some injustice to the complexities both of Taylor's and of Cornford's understanding of the term.

Thus the formula I have used to epitomise Taylor's interpretation, that the *pathemata* or the *pathe* are 'characters of the various bodies themselves', and not 'effects produced by the bodies on a percipient' (*Commentary* 431), is taken from Taylor's criticism of Cook Wilson, *On the interpretation of Plato's 'Timaeus'* 113-15, who in turn means to criticise Archer-Hind. Archer-Hind (p. 225) had written that, exceptionally, at 61D1 (Plato's 'postponement'), 'πάθημα signifies a quality pertaining to the object which produces this impression on the subject'. Cook Wilson replies that on the contrary, here as elsewhere, πάθημα is 'the name of the subjective impression', and not 'the quality in the object which causes it'. We are therefore faced with the rather odd position that Taylor apparently means to extend to Plato's use of πάθημα generally a meaning which had originally been presented as an exception to, or as altogether absent from, Plato's normal usage.

Taylor's further remarks on the nature of *pathemata*, *Commentary* 431-2, seem to me both ambiguous and confusing. But I have decided that despite the difficulty of deciphering exactly his intentions, and despite the doxographical oddity of the origins of his interpretation, it is fair to attribute to him an 'objective' as opposed to Cornford's 'subjective', conception of *pathemata*, since Taylor does conclude by writing, *Commentary* 432:

'If I had no body, or none which the tetrahedra of fire could penetrate, fire would still be θερμόν, but its heat would no more be directly revealed to me by sense than the distinctive character of a magnetized iron bar is. It would be in the coals, but it would be something inferred, not felt.'

This seems to me, irrefutably, an 'objective' conception of the *pathemata*: a clear statement of the view which I believe Plato intended to *refute*.

The confusion in Taylor's account is in fact a telling example of the disastrous results of attempting to accommodate Plato's ideas to the

theories of Whitehead. Thus when Taylor criticises Cook Wilson for seeming 'to credit Timaeus with a "bifurcation" of nature for which the text gives no justification' (*Commentary* 431), he might more properly have turned the knife against himself. For Taylor's criticism of Cook Wilson, and his interpretation of Plato's *pathemata* more generally, is a thinly veiled attempt to read into the text of the *Timaeus* the 'objective' theory of scientific knowledge put forward by Whitehead in *The concept of nature* (see esp. ch. II pp. 26ff.: 'Theories of the bifurcation of nature').

(ii)

And yet Cornford's 'subjective' interpretation is in practice hardly more satisfactory than Taylor's 'objective' interpretation: the confusions are more subtle perhaps, but ultimately they are no less disruptive of the clarity and the simplicity of Plato's original conception.

Thus at first sight Cornford's account of the *pathemata* at 61D1 appears to be exactly opposed to the interpretation which Taylor had adopted, *Cosmology* 259:

"Qualities (affections) connected with sensation" (τὰ παθήματα ὅσα αἰσθητικά) are distinguished from those properties which bodies are supposed to possess in the absence of any sentient being, such as the shapes of the microscopic particles, which are never perceived.'

This, Cornford tells us on the same page of his commentary, is exactly in line with the theory of the *Theaetetus*:

'Only when organ and object are in commerce with one another is the organ affected in such a way that (if the change penetrates through the body and reaches the soul) we have the situation we call "seeing white" or "feeling hot". And it is only while this situation endures that the object *becomes* white or hot *for* the percipient.'

But Cornford does not stick to this firm statement of policy. Thus earlier (*Cosmology* 148 n. 2) he refers to this same passage (61C-D) in an attempt to distinguish 'the perceptible "qualities" of external bodies', which is the meaning Cornford now gives to *pathemata* at 61C-D, from *pathemata* as "'affections" of the sentient body, causing sensation in the soul'. It is very difficult to see how 'the perceptible "qualities" of external bodies' which in this earlier passage of his commentary are explicitly *distinguished from* "'affections" ... causing sensation in the soul' (*Cosmology* 148 n. 2) can possibly be *the same as* those 'qualities' or 'affections' which ten pages later (*Cosmology* 259) Cornford tells us, with great firmness and deliberation, can exist only in the conjunction between perceived object and percipient.

The apparent inconsistency in Cornford's account is neatly brought out by a later writer, Dietrich J. Schulz, *Das Problem der Materie in Platons 'Timaios'* (Bonn, 1966) 34 n. 116. Schulz appears to want to summarise Cornford's distinction between the two meanings of *pathema* (he refers to *Cosmology* 148 n. 2), and writes (I think without any conscious irony) that:

'Die Worte πάθος oder πάθημα, die Platon als Sammelbegriff für die Qualitäten verwendet, enthalten ja die merkwürdige Unbestimmtheit, dass sie sich als Eigenschaften der Dinge, aber ebenso—vielleicht noch eher—als Eigenschaften des Erkennenden, der Seele, verstehen lassen.'

Here the meanings which Cornford had sought to distinguish are rolled into one. And yet it is difficult to complain that Schulz has misrepresented Cornford's intention, since Cornford does seem to have gone some way to adopting both positions at once: at 61C the *pathemata* are 'the perceptible "qualities" of external bodies' and *not* "'affections" ... causing sensation in the soul' (*Cosmology* 148 n. 2), and yet at the same time they exist only when being perceived (*Cosmology* 259).

In any case, whether conceived as two ideas or as one, Cornford's formulations do little to help the anxious enquirer into Plato's meaning. The distinction between *pathemata* as 'the perceptible "qualities" of external bodies' and *pathemata* which exist only in the conjunction between perceived object and percipient is an impossible will-o'-the-wisp, if we are to try to choose between one or other meaning for Plato's every use of the term. On the other hand, if Cornford's intention is rather as Schulz states it, and if both meanings are present in each use of the term, then the proposed solution is hardly more than a re-statement of the problem.

(iii)

Part of the reason for Cornford's confusion is that, like Taylor, he has failed to understand Plato's distinction between the common and the particular *pathemata* (for Taylor's error, see above pp. 130-4).

In his introduction to 'the greatest and the last of the common *pathemata*' (64A2-6), Plato tells us that pleasures and pains may accompany both 'what we have already described' and no less such things—presumably *pathemata*—as 'acquire sensations through the parts of our body and which bring in their train pains and pleasures together'. Cornford claims to see in this passage what is presumably intended to be the same distinction that he had put forward in the note which Schulz has seized upon. Cornford now formulates this distinction as lying between 'qualities of objects as perceived' and "'affections" occurring within the body and transmitted through the organs to the soul, where they "acquire" sensation' (*Cosmology* 267 n. 1, *cf.* 148 n. 2). But there is in this

passage no such distinction. Plato's meaning (64A2-6) is that pleasures and pains may accompany both 'what we have already described', namely the common *pathemata* of hot and cold, hard and soft, heavy and light, and rough and smooth (cf. 61D5-64A1), and no less the *pathemata* which reach us through particular 'parts' of the body, a simple forward reference to the account of the particular *pathemata* which will follow immediately Plato's analysis of pleasures and pains (65B6ff.: τὰ ... ἐν ἰδίοις μέρεσιν ἡμῶν γιγνόμενα, τὰ τε πάθη καὶ τὰς αἰτίας αὐ τῶν δρώντων).

This difference between the common and the particular *pathemata* carries with it no difference between an 'objective' and a 'subjective' status for the *pathemata*, as Cornford's formulations seem to require. 'Hot' and 'cold', for example, are no more, and no less, 'qualities of objects as perceived' than are, for example, 'sweet' and 'sour', which are listed with the particular *pathemata* (65C1ff.) for no other reason than that our perception of them is exclusively by means of a 'part' of the body, namely the tongue. Plato's point (64A2-6) is quite simply that pleasures and pains may accompany both our tasting 'sweet' and 'sour', *pathemata* which are restricted to the tongue, and no less our experience of 'hot' and 'cold', *pathemata* which are not restricted to any one part of the body.

That the over-elaboration in Cornford's account is not the product of some evasive subtlety of conception, but is rather the result of lack of clear thinking and of Cornford's failure to distance himself sufficiently from Taylor's 'objectivist' interpretation of the *pathemata*, is neatly and tellingly brought out by a slight, but significant, mistranslation of Plato's account of the *pathema* of heat. Plato tells us (cf. pp. 113-15 above) that the *physis* of the tetrahedra which constitute fire, 'by chopping our bodies up into little pieces, appropriately enough gives rise to the *pathema* which we call "hot" as well as to the name <"hot">', 62A2-5: φύσις ... κατὰ σμικρά ... τὰ σώματα κερματίζουσα τοῦτο δὲ νῦν θερμὸν λέγομεν εἰκότως τὸ πάθημα καὶ τοῦνομα παρέσχεν. Taylor, faithful to his conception of the *pathemata* as 'characters of the various bodies themselves', translated *pathema* here as 'quality': the nature of the tetrahedron 'has naturally made us acquainted with the quality we now call heat, and with the word itself' (translation, 63). Cornford not unexpectedly shies away from this threateningly objective view of the *pathema* as a 'quality', and prefers to have Plato write of an 'affection'; but at the same time he is unable to rid his translation of Taylor's 'quality'. He translates, *Cosmology* 259-60: 'this substance ... naturally gives the affection we call "hot" its quality and its name.' In this translation, *pathema* has to do duty—impossibly—both for Taylor's 'quality' and for Cornford's 'affection'.

The duplication in Cornford's translation may at first sight seem a trivial error; in fact it is crucial. Cornford's translation presents us with

four entities: the triangles, an 'affection', a 'quality' and a name. Plato's text presents us with only three entities: the tetrahedra, the effect they produce upon a second body, our own or another, and the name we give to this effect. For Plato's theory is designed precisely to avoid, subsequently to the production of the elemental particles, the need for the existence of any 'quality' or entity other than the *pathemata* produced by the elemental particles and the names we give to these *pathemata*, when and if they reach the *phronimon* and are there registered as sensations (cf. pp. 138-43 above). Here as elsewhere, a seemingly small unfaithfulness to the text is enough to undo the whole economy of Plato's conception in the *Timaeus*.

(iv)

Taylor and Cornford are not alone in their implicit attempts to provide respectively an 'objective' and a 'subjective' assimilation of the earlier and the later theories of weight in the *Timaeus*. For example, Taylor's remark, quoted earlier (p. 125, *Commentary* 441), that Plato's theory 'is really in the true line of thought which ultimately leads to our modern notions about gravitation', reminds one curiously of the remark in Martin, *Études* ii 276:

'Évidemment il y a loin de tous ces systèmes (*sc.* de l'Antiquité) à la théorie de la gravitation universelle. Le système de Platon est le seul où l'attraction ne soit pas niée.'

It would not be uncharacteristic of Taylor to forget the qualification, and to exaggerate the similarity. More significantly, the attempted assimilation of Plato's two theories which I have suggested underlies Taylor's remarks on gravitation (pp. 124-5 above), is to be found, but more explicitly, in Martin, who deliberately invokes the earlier theory in the long note which accompanies Plato's account of weight as defined by resistance (*Études* ii 272-8 = Note 104 'De la pesanteur et de la chute des corps'; this note is mostly taken up with post-Platonic and even post-Aristotelean theories of weight). Martin's idea is that fire, having the smallest number of particles, will move towards the region which is proper to it with the least force of any of the elements. He writes, 273:

'Platon admet que la force avec laquelle un corps tend vers sa région propre est proportionnelle à la masse de ce corps, et que les corpuscules élémentaires les plus petits ont la place la plus éloignée du centre du monde. Car c'est évidemment d'après ces principes sous-entendus qu'il a classé les quatre espèces de corpuscules élémentaires suivant leur grosseur et leur pesanteur en même temps.'

There are several difficulties in this seemingly simple comment, not least the apparently modern use of the concepts of 'force' and 'mass'. Why, for example, does Martin suppose that the smallest 'elementary corpuscles' move towards the place that is furthest removed from the centre? Is it because he has implicitly adopted the Newtonian conception of the universal attraction of mass, so that the body with least 'mass' will have least 'attraction' to the centre, since it is at the centre that the heaviest bodies, earth and water will be found?

Whether or not Martin intended this implication, his attempted association of Plato's earlier and later theory fails for the same reason that Cornford's 'subjective' interpretation fails (pp. 125-7 above), namely that in Plato's later theory there is no overt comparison, in terms of heavy and light, between different elements. The observer at the centre and the imaginary observer at the circumference each compares different quantities of the same element, and therefore the principle which Plato employs to explain the distribution of the four elements to different places in the cosmos cannot be, as Martin seems to imply it is, the criterion which determines directly the comparison between different quantities of fire or between different quantities of earth, in the later passage.

Nonetheless, Martin's commentary is distinctive in attempting to join Plato's two analyses, and further reflection on the part of Martin's commentary which I have quoted could have led to the conciliation of the two theories which I have suggested, since—divested of its anachronistic clothing—one could claim that in the first half of the first sentence quoted Martin does disengage the principle common to both theories: 'la force avec laquelle un corps tend vers sa région propre est proportionnelle à la masse de ce corps.' But in practice even this promising beginning to Martin's note is crowded out by a host of other considerations which have much less to do with the detailed interpretation of Plato's text, and it is not surprising therefore that Martin's embryonic conciliation of the two theories should have been ignored, even by subsequent French writers. Robin, for example, refers to Martin in juxtaposing the two passages, although without making any very explicit connection of ideas between the two theories, in an early article, 'Études sur la signification et la place de la physique dans la philosophie de Platon', *Revue philosophique de la France et de l'étranger* 86 année 43 (1918) 177-220 and 370-415, esp. pp. 210-11 (= *Pensée hellénique* 231-336, esp. pp. 270-1). Twenty years later, Robin had lost even this vestige of potential insight, and in his *Platon* (Paris, 1935) 239-40 (= [2nd edn] 1968, 174), he draws exclusively on the later passage for his account of Plato's theory of heavy and light.

(v)

Martin's interpretation, I have noted, fails for the same reason as Cornford's attempted conciliation of the two passages. Cornford's claim (*Cosmology* 222 n. 4, cf. pp. 125-7 above) that 'It will be easier to force a fire pyramid in among the octahedra of air, than to force an octahedron in among the pyramids', again fails to take account of the comparison, in the later theory, between different portions of the same element, or, if it does, would appear to lead to the opposite result to that required by the definition of weight in terms of resistance, since it is the larger quantity of fire which will have the greater number of cutting edges and which should therefore presumably be the easier to move. There is in any case no mention, in Plato's earlier or in his later theory, of the resistance of the medium; this, as I shall hope to show in my third and fourth volumes, is a specifically Aristotelean conception which has no obvious place in Plato's preoccupations.

It is perhaps the Aristotelean association which leads Zannoni, in his commentary on the *De caelo*, to seize upon this feature in Cornford's interpretation of the *Timaeus*, with the difference that Zannoni does attempt to apply Cornford's criterion to the distinction between different quantities of the same element. Thus in Zannoni's account of Plato's theory, p. 184 n. 3 (= p. 188), the resistance experienced by the sentient observer in comparing different quantities of fire is explicitly said to be determined by the resistance of the medium:

'... di due volumi di fuoco tratti a basso da una forza estranea, quello minore scende più speditamente in quanto deve vincere la spinta all'alto di una minore superficie d'aria; viceversa quello maggiore richiederà un maggiore sforzo perchè spinto all'alto dalla maggiore massa d'aria circostante'.

Zannoni neatly avoids here the idea which would seem to be implicit in Cornford's original suggestion, whereby the larger quantity of fire would have the greater cutting power and would be easier to move. Instead, by taking the larger or smaller surface of the resisting medium as the operative factor, Zannoni does arrive at the correlation required by Plato's account of weight as defined by resistance: the smaller quantity is *easier* to move. But precisely because Zannoni's interpretation is more directly and explicitly attached to the idea of the resistance of the medium, the more obvious it becomes that this whole conception has no real foundation in Plato's text. The only conception which appears explicitly in Plato's account of resistance is that there will be a greater attraction between the larger quantity of fire and the main mass of fire, and that the larger quantity will therefore require greater force to pull it away from the circumference. The resistance of the medium is an Aristotelean

conception, for which Plato's theory provides no obvious opening, and of which it has no particular need.

(vi)

In all these accounts of Plato's theory, the underlying error, it seems to me, is the neglect of Plato's own preoccupation: the nature of the *pathemata*, the relation between *pathemata* and sensation. It is this perspective which alone explains, I believe, both the advantages and the disadvantages in Plato's own attempted conciliation of the two theories. It is true, Plato does not provide, as Aristotle will do, for a comparison between different elements, or rather he does not do so in his account of weight as defined by resistance. But then Plato's major concern at this point in his treatise is not with weight as such, but with the sensation of weight. Plato is content to stop short once he has integrated into his theory of our sensible perception the phenomenon mainly appropriate to our life on earth, namely our weighing of 'earth' and of 'substances like earth' (cf. 63C6-7). And this he has done, in essentials, once he has provided, as the minimal conditions for the *pathemata* appropriate to weight, the differences in size and in direction of movement which have been established in his account of heavy and light among the *gene*.

It is again Martin who, paradoxically, has come closest to this conception of Plato's intention, and who has also done most to keep subsequent commentators from following the same path.

Martin's note on 64C3, Plato's account of why some *pathemata* do not produce sensation, seems to me irreproachable. Martin writes, *Études* ii 281 (= Note 111):

'Il faut donc bien distinguer l'impression physique, πάθημα, de la sensation, αἴσθησις, qui ne résulte de l'impression que lorsque celle-ci est transmise jusqu'à l'âme. Ainsi un homme dont le nerf optique est paralysé éprouve l'impression physique de la lumière, mais sans aucune sensation.'

But, as often in Martin's commentary, the occasional clear insight is smothered by considerations which tell in a very different sense. Thus in the note immediately preceding (Note 110 = *Études* ii 281), on Plato's general introduction to the *pathemata* of pleasures and pains (64A2-6), Martin (quite unnecessarily) attributes to Plato precisely the opposite intention:

'Ainsi, d'après l'expression de Platon, le feu renferme en lui-même la souffrance qui accompagne nécessairement la brûlure.'

It is true that Martin adds: 'Cette manière métaphorique de s'exprimer manque d'exactitude.' But this remark is given only as a censure of

Plato's position; it is not suggested that Plato himself saw the 'inexactitude' in the expression which Martin attributes to him, with the result that Martin's interpretation of Plato at this point is fully as objective as Taylor's own (*Commentary* 432: 'If I had no body ... fire would still be θερμόν').

But even more fatal than the general inconsequentiality of Martin's account of Plato's *pathemata* is the difficulty that Martin raises over the *pathemata* peculiar to heavy and light. For here Martin explicitly abandons his general conception of *pathemata*. Thus when Plato describes 'heavy' and 'down' as 'the opposite *pathos*' to what is 'light' and 'up' (63D2-4), Martin objects that *pathos* must here mean 'manière d'être', since it cannot have what is for him its usual meaning of 'impression physique'. He writes, *Études* ii 278-9 (= Note 105):

'Ordinairement, dans le *Timée*, le mot πάθος désigne une impression physique. Or, qu'on appelle la pesanteur une impression, cela se conçoit, puisque nous sommes affectés d'une certaine manière quand nous voulons soutenir un corps pesant. Mais que le *bas* ou le *haut* soient appelés des impressions, voilà ce qui ne se conçoit plus. Il faut donc croire qu'ici πάθος signifie simplement manière d'être.'

As too often, Gallic logic creates its own problems, and fails to solve them. It is true that in the expression which Martin has seized on (... τὸ δ' ἐναντίον τούτοις πάθος βαρὺ καὶ κάτω, 63D3-4), weight and direction are so to speak put on a par. But Plato does not say, nor I think does he mean, that differences of direction can be treated as *pathe* or *pathemata* independently of the opposition of weight. The simple answer to Martin's objection is therefore that we do not have a separate *pathos* of direction. The *pathemata* which Plato will claim to have explained (*cf.* 63E7-8) are the *pathemata* of heavy and light. 'Up' and 'down' are introduced, not as themselves *pathemata*, but as indispensable to the explanation of heavy and light (62C3-4). Thus in the explanation I have given (pp. 153-7 above) quantity and direction are so to speak the two ingredients which determine our 'impression' of heavy and light. We no more 'feel' the *pathemata* of 'up' and 'down' independently of the movement of different quantities of earth in either direction than we can 'feel' the difference of quantity, if neither portion of earth were moving towards or away from its parent body. 'Up' and 'down' are not therefore to be paired with hot and cold, or rough and smooth, or sweet and sour, independently of the *pathemata* of heavy and light.

Once this (fairly obvious) distinction has been made, then there is no longer any justification for giving *pathema* or *pathos*, in relation to 'heavy' and 'light', the special sense of 'manière d'être'. On the contrary, within the account of weight, the words *pathema* and *pathos* will be intended to

have precisely the meaning which those terms have elsewhere in Plato's argument, and which Martin has analysed correctly in his account of πάθος and αἰσθησις.

(vii)

But while this is the simplest answer to Martin's objection over the existence of *pathemata* of heavy and light, I am not sure that it is the whole answer.

On the very page where he proposes to treat πάθος as simply a 'manière d'être', Martin returns to the account that he had given of 'up' and 'down' as relative purely to the position of an element, with the consequence, according to Martin, that what is 'up' for one element is 'down' for another (*Études* ii 273 and 279, quoted p. 337 above). To this Martin now attaches the reading of the *Timaeus* whereby fire which is lighter than earth at the centre is heavier at the circumference, and *vice versa* for earth (*Études* ii 279-80 = Note 107 'Du haut et du bas', see pp. 327-8 above). From this it would seem to follow that, on Martin's interpretation, the oppositions of weight and of direction are no longer aligned as they are by Plato, both in his account of the observers at centre and at circumference (63B2ff.) and in what I have called his final definition (63D3-7). For Plato, the body which is *heavy* moves *downwards*; the body which is *light* moves *upwards*. But for Martin, earth will be *lighter* than fire when measured at the circumference, but will nonetheless be moving *downwards* when it moves away from the circumference and towards the centre. There will be the same dislocation, if we attempt to extend Martin's interpretation to include the comparison between different quantities of the same element. Martin himself stops short at the comparison between different elements, but if we seek to adapt Martin's principles to Plato's own comparison, in the later theory, between different quantities of the same element, still supposing, as Martin has done, that whatever comparison is made at the centre will also be made at the circumference, but with the opposite result, then we arrive at the full-blooded extension to Plato's theory which occupies the page of Taylor's commentary. Measured at the circumference, the larger quantity of earth will be 'lighter' and the smaller quantity 'heavier', and yet both quantities will be reckoned as moving 'downwards', if we imagine both stones as returning to the centre, and therefore as moving towards their parent element (cf. *Tim.* 63E3-7; Martin, *Études* ii 273: 'le bas, c'est le siège principal du genre de corps auquel il appartient').

It is, I suspect, this potential dislocation between the oppositions of weight and of direction which makes Martin think of 'up' and 'down' as *pathemata* so to speak in their own right, and divorced (or divorcible) from

the *pathemata* of heavy and light. In Plato's own theory, as I have reconstructed it, there is no occasion when we would have to dissociate 'light' and 'upwards' or 'down' and 'heavy'; but the consequence of Martin's interpretation would appear to be that what is light may be reckoned *either* as moving upwards (the smaller quantity of earth measured at the centre) *or* as moving downwards (the larger quantity of earth measured at the circumference), and we therefore have to calculate the difference of direction independently of the difference of weight.

Martin's remarks on the *pathos* of 'up' and 'down', I suspect, may issue from an implicit awareness of this potential discrepancy, which is indeed a consequence inherent in his own interpretation of Plato's theory. Thus when, in the passage Martin has quoted, Plato writes that 'we call the opposite *pathos* "heavy" and "down"' (63D3-4), the link which joins those two opposite 'names' in Plato's theory has already been weakened by Martin's interpretation of the theory. It is true that, for the comparison between different quantities of the same element, that link will be finally broken only in Taylor's re-writing and enlargement of Martin's interpretation, but the breakage I suspect can already be foreseen in Martin's claim that the opposition of direction should be treated as giving rise to *pathemata* independently of the opposition of weight.

NOTE 8

NAMES

(i)

Plato's general intention in the *Timaeus*, or so I have argued, is that we should apply the name 'cold', for example, not only to our sensation of cold but also to the agent which causes our feeling: we say both 'I feel cold', and 'the wind is cold' (cf. *Tim.* 62B4-6, and pp. 147ff. above). In the case of weight, therefore, we may expect to find the names 'heavy' and 'light' applied retrospectively, as is the case also for temperature or flavour, to the particles that act as the agent of our perception. This we do find, in the successive descriptions of fire as 'lightest' (56B1), of water as 'heavy' (58E2), and of copper as 'lighter' than gold (59C1: for fire and water, cf. pp. 81ff. above; for copper and gold, cf. pp. 89ff. above).

From this point of view, the factor which unites Plato's two analyses is the correlation of weight with a smaller or larger number of elemental triangles. Thus among the *gene*, fire is 'lightest' because the tetrahedron is the figure with the smallest number of triangles (cf. 56B1-2), water is 'heavy' because it is made from 'large' particles (cf. 58E1), while copper is 'lighter' because it has large interstices (cf. 59C1) and so fewer triangles than gold. In the same way in the account of the *pathemata* (63A6ff.), the larger quantity of fire or earth, and therefore the quantity which has more triangles, feels heavier, while the smaller quantity of either element, the quantity therefore with the smaller number of triangles, feels lighter.

From this point of view, therefore, the more immediate view of the comparison of quantity, the 'two' theories correspond well enough. But the later theory adds to the comparison of quantity an analysis of direction, which is tied to the theory of weight, and which Plato introduces as requiring a correction of our everyday vocabulary. According to this 'corrected' vocabulary an element moves 'downwards' and is 'heavy' only when it moves towards its parent body, and it is 'light' and moves 'upwards' only when it is moving away from its parent body (cf. 63E6-7).

Does the description of fire as 'lightest' (56B1) mean then that fire is moving away from its parent body? Fairly clearly, not.

Does even the corrected vocabulary for direction reach back into the earlier parts of the *Timaeus*? Let us see.

(ii)

There are two instances when Plato speaks of 'up' and 'down' in the account of the *gene*. In neither case does he employ the revised or corrected terminology that is recommended in his later analysis.

The movement of the whole, Plato tells us, exerts a constant pressure on the primary particles, forcing them to react upon one another, and keeping up thereby a constant interchange among the three transformable elements. The smaller particles of fire, with their sharp edges and angles, break open the larger particles. The larger particles squeeze the smaller ones together and force them to recombine as air or water. The change of size forces a change of place. 'The elements are all carried upwards or downwards to the places that are proper to them', 58B8: πάντ' ἄνω κάτω μεταφέρεται πρὸς τοὺς ἑαυτῶν τόπους. Different interpretations could perhaps be squeezed out of this passage, but it seems unlikely that 'up' and 'down' are used here in any other than a conventional sense to mean towards the earth and away from it; we are hardly expected to anticipate here Plato's later analysis of direction, and to conclude that the only elements which are moving 'downwards' are those which are moving towards their proper place.

The same is obviously true in the second case, where air which has been produced as a by-product of the formation of rocks 'runs up to its proper place', 60C1: ... ἀπὸ πρὸς τὸν ἑαυτοῦ τόπον ἀναθεῖ. It would be impossibly pedantic to object that in moving towards its proper place air should be reckoned as moving 'downwards'.

(iii)

The inconsistency is not limited to the pages preceding Plato's analysis of *pathemata*; if we consider the allusions to 'heavy' and 'light' and 'up' and 'down' in the pages following the analysis of *pathemata*, it is again far from obvious that Plato is employing the 'corrected' terminology that he has now advocated.

Thus hot substances continue to move 'upwards' because of their 'lightness' (φερόμενά τε ὑπὸ κουφότητος ἄνω ..., 65E6-7); fairly clearly this does not mean that the smaller quantity of fire moves *inwards* from the *circumference*. In the context, the meaning is evidently that mustard, or other hot spices, are driven upwards, by their heat, from the mouth to the nose and eyes: fire, in this context, is 'light' and moves 'upwards' in the conventional sense.

It is true that Plato's later allusions to heavy and light, in the third part of the *Timaeus* (69Aff.), do conform to his general intention, or so I have argued, in so far as they are subordinated to the teleological purpose of

this final part of Plato's treatise (*cf.* pp. 165ff. above). But again there is no sign of the radical correction of the terminology associated with heavy and light that Plato had recommended in his analysis of the *pathemata*.

Thus hair is 'light' because it is made in part of fire (χοῦρον, 76D1). In the disruption brought about by illness and disease 'heavy' and 'light' change place (82A7-B2). It is true that in the first passage 'fire' and 'light' are associated, as they are in the account of the *gene* (*cf.* 56B1); but if we try to visualise the rôle of fire in the formation of hair, it would obviously be artificial, if not impossible, to claim that the fire which forms our hair is 'light' because it is moving *inwards* from the *circumference*.

In the second passage, the immediate addition, in the context, of 'hot' and 'cold' and 'wet' gives a strong impression that 'heavy' and 'light' are again used in an equally traditional, and conventional, sense, and not in the special sense that would be required by Plato's analysis of the *pathemata*.

(iv)

I summarise briefly. The general intention of Plato's theory, the inclusion of 'heavy' and 'light' among the affections of sense, is clear and consistent: but how far has Plato succeeded in realising his intention?

One test lies in Plato's theory of names: 'hot' and 'cold' no longer, in Plato's theory, exist as intrinsic qualities or powers; they result solely from the conjunction of perceived object and percipient, but with the refinement, in the *Timaeus*, that we may then transfer the name from our 'feeling' to the object in the external world which arouses in us the feeling. For most opposites the choice of name is uncontroversial. For there is no question of what we normally feel, nor of how we normally express ourselves, when we warm ourselves in front of a fire, or when we shiver with cold. In the case of temperature therefore Plato's account is designed solely to explain the underlying physical causes which produce the *pathemata* that on a conscious and sentient level lead us to speak of being hot or of feeling cold. But there is the difference, in the case of heavy and light, that Plato's later account begins with a criticism of earlier ideas, and with an analysis of direction which is designed to correct our habitual and customary ways of thinking. It is as though—very loosely—we were told that in future we should talk of feeling hot only when we actually break out into a sweat, or as though we were told that we had been wrong to say that we felt cold, when we meant only that we were stiff or uncomfortable.

There are two questions therefore. Why has Plato been forced to adopt, for the analysis of direction and weight, this revision of our every-

day vocabulary? And why is he not faithful to the consequences of his analysis elsewhere in the *Timaeus*?

The answer to both questions, I suggest, lies in Plato's innovation in attempting to reduce heavy and light, no less than hot and cold or sweet and sour, to what Theophrastus will call 'affections of sense' (cf. pp. 289ff. above).

In order to undermine our belief in the 'objective reality' of the differentiation of heavy and light, Plato attempts to persuade the reader that we are wrong to use 'heavy' and 'light', 'up' and 'down', as though those words had each a single and exclusive reference. Plato attempts to show that those terms would be used with what Plato claims is an opposite reference by the observer at the centre and by an observer at the circumference. Hence the paradox (cf. 63D6-E3) that 'what is light or heavy, up or down, in one place is the opposite of what is light or heavy, up or down, in the opposite place'.

This interlocking of weight and of direction enables Plato to arrive at his general aim, which is to suggest that since the differentiations of weight and of direction give rise to perceptions that are 'opposed', they cannot therefore be regarded as properties or powers intrinsic to the objects of our perception, in just the way (or so Plato would here have us believe) that the wind which can appear both hot and cold, or wine that can taste both sweet and sour, cannot be characterised exclusively by either one of the pair of opposites, and so cannot be in itself either hot or cold, or sweet or sour.

On the other hand, once Plato has arrived at this point then there is no particular need for him to maintain the distinctive vocabulary which he had introduced in order to undermine the traditional status of heavy and light, and up and down, as properties or powers belonging to the elements and to the parts of the universe, independently of our perception of them. Outside the immediate area of the analysis of the *pathemata*, Plato can quite happily fall back on that approach to the deficiency of language which had been a common theme, of earlier philosophers and of Plato himself. When Plato tells us in the *Theaetetus* that we speak of things which 'exist' only because our minds are clouded by habit (cf. 157A7-B3); or when Empedocles tells us that there is no coming-into-being or passing-away but only the mixture and separation of unchangeable elements (cf. fr. 9; for both passages see pp. 146-7 above), neither philosopher actually expects us to change our everyday vocabulary: Empedocles says expressly that he will continue to obey the 'convention' of language.

Initially, the analysis of the *pathemata* of heavy and light is an exception to this tradition: for here Plato does claim to introduce a new and im-

proved vocabulary, significantly different from the vocabulary that is ours by habit. But Plato's aim is not therefore to establish a technical vocabulary, free from the imprecision of normal usage. Plato's aim is simply to achieve for heavy and light what had already been achieved by Democritus for the other sensibles: namely that opposite 'names' do not attach directly to powers or qualities independent of our perception. Once that aim has been achieved, then Plato—and his reader—can happily revert to the vocabulary that is ours 'by habit' (cf. 63A7).

Thus the 'cosmic traveller' (63A2-4) will call the same part of the earth's surface 'up' and 'down' in turn; he will no doubt continue to do so, even when he realises that these 'names' do no more than reflect his own relation to a body of which no part is in itself, or 'by nature', up or down. In the same spirit, we shall continue to speak of earth as 'heavy' and as moving 'downwards', when, on earth, we weigh different quantities of earth, recognising that these 'names' reflect, not some intrinsic property or power, but merely the relation between our body and the movement of earth towards its parent element. And if, at the same time, we continue to speak of fire as moving 'upwards' when it moves away from the centre, this will no longer be because we suppose that 'up' and 'down' are opposite places which 'divide the whole between them', and that fire moves 'upwards', i.e. away from the surface of the earth, only 'involuntarily' (cf. 62C5-8). We shall recognise that this vocabulary is a false extrapolation from our experience on earth, where we deal habitually with 'earth and with things like earth' (cf. 63C6-7), even if we continue to use, for fire as for earth, the vocabulary that is ours 'by habit'.

(v)

From this point of view, therefore, the theory of 'names' brings out nicely the difference between the two criteria of quantity and of movement in Plato's analysis of heavy and light among the *pathemata*, a difference which I have already touched upon in my final chapter (pp. 299ff. above).

When Plato writes that fire is 'lightest' because it is made from 'the smallest number of like parts' (56B1-2), the correlation of weight and quantity is the same as in the analysis of weight among the *pathemata*, at least for the comparison between different portions of the same element: the larger quantity of fire or of earth is heavier, the smaller quantity is lighter (63A6ff.).

But the same is not the case for the analysis of movement and of direction in the later theory. According to this analysis, fire which is 'light' or 'lightest' should be fire which is moving away from its parent body (esp.

63E3-7). But there is no indication that this is Plato's intention, when he writes of fire as 'lightest' in his construction of the geometrical solids (56B1).

The anomaly arises because the association of weight with movement has been added as a correction of our everyday vocabulary, designed specifically to undercut the exclusiveness, and therefore the seeming objectivity, attaching to the language which is ours 'by habit'.

For weight as defined by quantity alone does not lend itself, easily if at all, to the paradox which had traditionally been employed to demonstrate the relativity of the objects of sense, and whereby the 'same' thing will appear differently to different percipients, or to the same percipient at different times. The larger quantity of earth or fire is for Plato, on the interpretation that I have offered of his theory, invariably the heavier.

Weight as defined by quantity alone does not even lend itself at all easily to the paradox which Plato will in fact employ in his analysis of heavy and light among the *pathemata*, and whereby 'opposite' things will appear, or be called, 'the same'. (Cf. 62D6-E3; and for the difference between the two forms of paradox, see my final Note, pp. 410ff. below.)

It is the addition of movement which enables Plato to reach at least this latter form of paradox, and so to suggest to his reader that heavy and light are no less relative to our perception than are hot and cold, or sweet and sour, which had traditionally been accounted as 'affections of sense'. For when the opposition of heavy and light as determined by quantity is attached to the opposition of up and down, and thereby to an opposition of place, it does become possible for Plato to provide the paradox whereby a larger quantity of fire at the circumference will be opposed to a larger quantity of earth at the centre: both portions will be 'heavy' and will be moving 'downwards'; and yet both portions are 'opposed', in so far as they move in opposite directions, fire to the circumference and earth to the centre.

Hence the anomaly whereby the opposition of heavy and light, in so far as it is an opposition of quantity, lends itself easily enough to Plato's theory of 'names', but does not contribute directly to the paradox; whereas heavy and light, in so far as they are related to direction and to an opposition of place, contribute directly to the formation of the paradox, but resist integration into Plato's theory of 'names'.

Thus weight as defined by quantity alone can be retained throughout the *Timaeus*: for 'heavy' and 'light', in this sense, answer closely enough to Plato's analysis of hot and cold, or sweet and sour. It is true that we do not perhaps 'feel' something as heavy or light in quite the same intimate way in which we 'feel' (ourselves to be) hot and cold. But that is a distinction which Plato has chosen to ignore. The parallel is in any case close

enough: we apply the names of hot and cold, or sweet and sour, to the agent of our perception; and in the same way we apply the names of heavy and light to the larger or smaller number of triangles. It is in this sense (or so I have argued) that Plato means to speak of fire as 'lightest', of metals as heavy, of copper as 'lighter' than gold.

We do not, in the same sense, attach 'up' and 'down' to the agent of our perception. We do so, in the special case described in the analysis of the *pathemata*: the comparison of different quantities of the same element by the use of a pair of scales. But once we no longer visualise ourselves at the circumference, weighing different quantities of fire, then we no longer speak of hair as 'light' or of fire as 'lightest' in the special sense required by Plato's correction of our everyday vocabulary.

For that correction of our everyday vocabulary has not been introduced to support the theory of 'names'. It has been introduced for its own specific purpose: as a new and paradoxical usage designed precisely to undercut the conventional assumption that the opposition of direction and the opposition of weight attach as intrinsic properties or powers to different parts of the cosmos and to the bodies which inhabit the cosmos.

The construction of the paradox has been achieved at the cost, one might say, of the theory of names. And that ultimately is why the correction of our everyday vocabulary does not extend beyond the analysis of the *pathemata*. For it is precisely by unmasking the falsity, or more exactly the partiality, in our everyday vocabulary that Plato is able to arrive at the paradox which will help to establish heavy and light, no less than hot and cold or sweet and sour, as 'affections of sense' (cf. 63D6-E3). And it is only once that purpose has been achieved that the 'names' of heavy and light will have the special connotation required by Plato's theory of perception.

From this point of view, to have *anticipated* the 'revised' vocabulary of Plato's final definition (63E6-7) earlier in the *Timaeus*, would not only have been impossibly cumbersome and confusing; it would also have defeated Plato's purpose, since it would have detracted from the innovation whereby we are brought to recognise that 'heavy' and 'light' do not have the objective existence which we seem to attribute to them in our conventional association of 'heavy' and 'light' with 'up' and 'down'. Equally, to have *retained* the 'revised' vocabulary, would have been hardly necessary, once that lesson had been learnt.

'UP' AND 'DOWN' IN THE *PHAEDO* AND *TIMAEUS*

I have so far (pp. 185-91 above) attempted to present the difference between Plato's theory of 'up' and 'down' in the *Timaeus* (62C3-63E8) and Aristotle's theory of 'up' and 'down' in the fourth book of the *De caelo* (iv 1, 308a14-29) from a point of view sympathetic to Aristotle. In doing so, I hope I have told the truth; I have certainly been guilty of not telling the whole truth.

One way to make amends, is to start from a point earlier in time than the *Timaeus*: this we can do, by studying the language Plato uses in the cosmology of the myth in the *Phaedo* (111C4-112E3). The 'directional' terminology which Plato uses in the *Phaedo* has been seen both as an anticipation and as a contradiction of the terminology which Plato uses in the *Timaeus*. I believe that it is neither, but something more interesting still. The language of the *Phaedo*, rightly understood, can give us useful insight, I believe, into the point of departure that was common to Plato and to Aristotle, and that still lies, half concealed and half revealed, in Plato's analysis of direction in the *Timaeus*.

Unfortunately, any comparison between the *Phaedo* and the *Timaeus* is hindered by controversy over Plato's meaning in the *Phaedo*. I must attempt to settle at least the essential outlines of Plato's meaning in the *Phaedo*, before I can hope to compare at all satisfactorily the language of the *Phaedo* with the language of the *Timaeus* and the *De caelo*.

(i)

I start from a traditional reading of the cosmology in the myth of the *Phaedo* (111C4-112E3): for example that given by O. Baensch, 'Die Schilderung der Unterwelt in Platons *Phaidon*', *AGPh* n.F. 9 (1903) 189-203. (Baensch's diagrams and text are a trifle complex, but they do at least avoid the more obvious errors in Harold Williamson, *The 'Phaedo' of Plato* [London, 1904] 231-5, repeated in Richard S. H. Bluck, *Plato's 'Phaedo'* [London, 1955] 135, cf. 127, 200-1; Gallop, *Phaedo* edn 223, chickens out of the whole question.)

On this reading, the earth of the *Phaedo* is spherical, and is pierced by Tartarus as by a central vertical core (esp. 111E6-112A5). The waters of Tartarus have no stable base, and so move up and down within this core (112A5-B4; ἄνω καὶ κάτω, B3; cf. 111E4). Followed by great winds, they move now to the far side of the earth from ours, and now to our own

(112B4-C1; esp. καὶ ὅταν εἰς τὸ ἐπ' ἐκεῖνα τῆς γῆς ὁρμήσῃ καὶ ὅταν εἰς τὸ ἐπὶ τὰδε, B4-6). When the waters of Tartarus withdraw to the far side of the earth from our own, i.e. to 'the place that is called below', they pump waters into the rivers of that hemisphere (112C1-4: esp. ὅταν τε οὖν ὑποχωρήσῃ τὸ ὕδωρ εἰς τὸν τόπον τὸν δὴ κάτω καλούμενον, C1-2). When they return to our hemisphere, they fill the rivers and the oceans on our side of the earth (112C4-D4; esp. ὅταν τε αὖ ἐκεῖθεν μὲν ἀπολίπη, δεῦρο δὲ ὁρμήσῃ, C4). The rivers which issue from either hemisphere invariably re-enter Tartarus at a point lower than the point by which they left, but they never descend further than the middle in either direction (i.e. within either hemisphere), since beyond that point they would be forced to flow uphill from either side (112D4-E3; esp. ἐκατέρωσε, ἐκατέρωθεν, E1-2).

So much for the traditional reading of the myth. An alternative interpretation has been put forward, independently and for quite different reasons, by T. G. Rosenmeyer, *CQ* n.s. 6 (1956) 193-7, and by J. S. Morrison, *Phronesis* 4 (1959) 101-19. (My references to Rosenmeyer are all to the article quoted; Rosenmeyer also defended his thesis briefly, *Phronesis* 4 [1959] 71-2, in answer to W. M. Calder's restatement of the traditional view, *Phronesis* 3 [1958] 121-5; rather interestingly, Morrison had earlier held the opposite view, *JHS* 75 [1955] 65.)

On this alternative reading of the myth, the earth is either (1) flat (Rosenmeyer, 193) or (2) hemispherical (Morrison, 118). Tartarus is either (1) a 'central cavity' which runs 'horizontally' (Rosenmeyer, 194 n. 3) or (2) more simply a 'central hollow' (Morrison, 112). The movement of the waters ἐπ' ἐκεῖνα and ἐπὶ τὰδε (112B5-6) is either (1) movement from one inhabited hollow on the earth's surface to another (Rosenmeyer, 195) or (2) movement towards the interior of the earth and movement towards the surface of the earth (this seems to be the meaning implied by Morrison's distinction between 'infernal' and 'terrestrial', p. 118). 'The place that is called below' (τὸν τόπον τὸν δὴ κάτω καλούμενον, 112C1-2) is either (1) 'the lower area' of the hollow in which we live (Rosenmeyer, 195), and in that case the particle 'indicates, with self-conscious emphasis, that our region has earlier been shown to rest at the bottom of a κοῖλον' (Rosenmeyer, 195 n. 3), or (2) Tartarus itself, and the particle then means either (2a) that Tartarus is low down in the earth, but not strictly underneath the earth, as it had been 'in the old poetic picture', or (2b) that Tartarus is not like the usual kind of sump, because instead of allowing water to collect 'below' it pumps it to the surface again (Morrison, 113-14). Finally, the impossibility of water flowing uphill 'from either side' (112E1-3) means either (1) that water which has flowed down one side of an inhabited hollow cannot flow up the far side (Rosenmeyer, 195-6) or (2) that streams which approach the centre clock-

wise or anti-clockwise cannot flow upwards when they have reached the centre (Morrison, 115).

Two explanations are never as good as one; here, we have different interpretations for every piece of 'directional' vocabulary in Plato's myth, and three for the crucial phrase: 'the place that is called below' (112C1-2). But the lack of agreement between Rosenmeyer and Morrison is less serious than the crucial weakness which both writers have in common: the interpretation they both give of Tartarus.

For it is the description which Plato gives of Tartarus which will enable us, most clearly and most simply, to choose between the traditional interpretation and the different versions of the interpretation offered by Rosenmeyer and Morrison.

(ii)

Plato writes specifically that Tartarus 'is pierced right through the whole of the earth' (διαμπερές τετρημένον δι' ὅλης τῆς γῆς, 112A1-2). The Tartarus of the *Phaedo* cannot therefore be, as it is in Morrison's account (p. 112), a mere 'central hollow'. A 'central hollow' does not 'pierce the earth right through'. Plato's Tartarus must be a central hollow core, not a mere 'central hollow'.

Rosenmeyer surmounts this hurdle, but falls at the next. His 'central cavity' is a central core, for it 'runs ... from one end of the earth to the other' (p. 194 n. 3). But at the same time Rosenmeyer's central core or cavity runs 'horizontally' (*ibid.*). But in that case it is difficult, if not impossible, to understand how the movement of the waters of Tartarus can be, as Plato tells us it is, a movement 'up and down' (ἄνω καὶ κάτω, 112B3; cf. 111E4). Movement in a horizontal channel can only easily be envisaged as movement from side to side. Movement 'up and down' much more naturally suggests a vertical, and not a horizontal, core.

But once Tartarus has been established as a central *vertical* core, running *from end to end* of the earth, then the game is almost up for the alternative interpretation. For Plato tells us specifically that rivers are filled at both 'extremes' in the movement of the waters of Tartarus (cf. ὅταν τε οὖν ὑποχωρήσῃ ..., 112C1; ὅταν τε αὖ ἐκεῖθεν μὲν ἀπολίπη, δεῦρο δὲ ὀρμήσῃ ..., C4). Taken in conjunction with the fact that the movement of the waters is a movement 'up and down' (112B3), this must mean that there are two sets of rivers, filled alternately, as the waters of Tartarus rise, and as they fall.

Two sets of rivers, issuing from the rise and fall of waters within a central vertical core, could conceivably be squeezed into a hemispherical earth; but it would be a tight squeeze. It is obviously far simpler to sup-

pose that the rivers filled alternately by the rise and by the fall of a vertical Tartarus, a Tartarus which pierces the earth 'the whole way through' (cf. 112A1-2), are rivers which occupy the upper and the lower halves of an earth at least roughly spherical, as in the traditional interpretation of the myth of the *Phaedo*.

(iii)

It would be tempting to pursue the details of the text: ὁ δὲ ... καλούμενος (cf. 112C2) is not Plato's way of referring to something he has said before (pace Rosenmeyer, 195 n. 3); Morrison gives no evidence that ἐκατέρωσε and ἐκατέρωθεν (112E1 and 2) can mean 'clock-wise' and 'anti-clockwise' (p. 115), etc. But I shall be kept too long from the *Timaeus* and the *De caelo*: the near-impossibility of explaining the position and the functioning of Tartarus on any other than the traditional interpretation is the one detail which, more perhaps than any other, shows up the weakness in the rival interpretation of the *Phaedo*.

There is in any case one question more, before I can compare the terminology of the *Phaedo* and of the *Timaeus*: what is the shape of the earth in the *Timaeus*?

Rosenmeyer, after a certain amount of vacillation, informs us that 'strictly speaking, the *Timaeus* tells us nothing whatever about the shape of the earth' (p. 193 n. 1). Morrison is adamant: 'There is nothing to show that the *earth*' in the *Timaeus* 'was envisaged as spherical' (p. 114). Fortunately, this is a question which can be easily settled.

Morrison has been misled by the claim that Plato writes of 'a spherical earth' at '*Timaeus* 62C' (Reginald Hackforth, *Plato's 'Phaedo'* [Cambridge, 1955] 178 n. 4). Morrison rightly objects that at *Tim.* 62C Plato writes of the universe, and not of the earth (hence his italics in the sentence I last quoted). But although Morrison then tells us that Plato 'deals with the matter at some considerable length' (p. 114), he has in fact obviously failed to read on as far as Plato's description of the central body (62E12-63A2) and the 'cosmic traveller' (63A2-4). For the central body introduced at 62E12 is clearly intended, in the context of Plato's argument as a whole, to represent the earth (see esp. pp. 17-18 above). Equally clearly, this central body is meant to be spherical: only so could the traveller 'walk all the way round it in a circle', find himself 'repeatedly standing head to foot' as he does so, and therefore call 'the same part of the body' at different times "'up" and "down"' (63A2-4; cf. pp. 17-23 above).

I would allow that, on a casual reading, Plato's account of the shape of the earth in the *Phaedo* is unclear, and even ambiguous (there could hard-

ly have been the controversy there has been, if it were not), even though I believe that such ambiguity as there is can be resolved by an attentive reading of the text. But Plato's analysis of direction in the *Timaeus* (from 62C3 to 63A6) is hardly even ambiguous. The declaration that 'strictly speaking, the *Timaeus* tells us nothing whatever about the shape of the earth', and still more the assertion that 'there is nothing to show that the earth in that dialogue was envisaged as spherical', are so obviously untrue that they can only have arisen from a failure to read this part of Plato's text at all.

(iv)

I conclude therefore that Plato describes a spherical earth in the *Phaedo* and in the *Timaeus*, and I turn to consider the terminology which he uses in either case.

Some connection between the two passages has been long suspected; but there has been no agreement as to what this connection may be. Thus Archer-Hind, looking back at the *Phaedo* from the *Timaeus*, complains that Plato has failed to adopt in the *Phaedo* the terminology which he will later advocate in the *Timaeus* (*Tim.* edn 230). Hackforth, looking forward to the *Timaeus* from the *Phaedo*, takes just the opposite view: he sees in the *Phaedo* an anticipation of the denial of any 'absolute' up and down, which Plato will put forward in the *Timaeus* (*Phaedo* edn 178 n. 4). Neither view, I believe, is correct.

As a preliminary move, I suggest we look again at the account which Plato gives in the *Timaeus* of what I have called the 'common error', whereby 'two opposite places divide the whole between them, "down" to which anything travels which has any body or bulk, and "up" to which things travel only involuntarily' (62C5-8; cf. pp. 5-9 above). Plato's 'common error' is the same, I would suggest, as the view which Aristotle attributes to 'the majority' in the *De caelo* (iv 1, 308a21ff.; cf. pp. 185-91 above).

Rather typically, Aristotle tells us only how 'most people' would speak of 'up' and 'down', if they agreed with himself: in a spherical universe, for Aristotle as for 'the majority', the centre is 'down' and the circumference is 'up' (308a21-4, a26-9). But Aristotle also tells us that 'most people' do not in fact recognise the universe as spherical; they are conscious only of the hemisphere above their heads (cf. 308a24-6). The implication is pretty plainly that what most people in fact believe is that the sky above their heads is 'up' and that the earth below their feet is 'down'. It is Aristotle's own happy conviction that once such people recognise that the sky is part of a spherical universe they will call the

whole of the circumference 'up', and that the earth which now becomes the centre of a spherical universe they will call 'down'.

If, for the moment, we hold back from subscribing to this same conviction, then the popular belief will be simply that the sky above our heads is 'up' and that the earth below our feet is 'down'; and this, I would suggest, is what is implied by Plato's 'common error', whereby 'up' and 'down' divide the whole between them (cf. *Tim.* 62C5-8).

On this suggestion, the point will be quite simply that either passage complements the other. Aristotle tells us (*De caelo* iv 1, 308a21-9) that most people think only of the hemisphere above their heads; he does not tell us, explicitly, how it is that they use 'up' and 'down' to express this belief. Plato (*Tim.* 62C5-8) tells us that people speak of 'up' and 'down' as opposite places which divide the whole between them; but he does not tell us what kind of world it is that is so described. My suggestion is that we put together the two halves of the picture: the terminology of the 'common error' in the *Phaedo*, and the hemispherical world of 'the majority' in the *De caelo*. The sky, the hemisphere above our heads is 'up'; the earth below our feet is 'down'; and in this sense "'up" and "down" divide the whole between them'.

(v)

It is true that this conclusion will exclude Simplicius' belief that Democritus is intended as the target of Plato's criticism (*De caelo* 269.4-14); but, as I had already noted (pp. 5-8 above), that belief is in any case excluded by Plato's identification of the 'common error' with the way in which 'we have grown accustomed' to speaking (cf. *εἰθίσμεθα*, 63A7). That expression tells in favour of our identifying the 'common error' of the *Timaeus* with the belief of 'the majority' in the *De caelo*; it excludes the possibility that Plato's criticism is restricted to any one individual thinker.

Simplicius' interpretation cannot be the whole truth; it may contain part of the truth. There are two features in Plato's criticism. Democritus will not be included with those who think only of the hemisphere above their heads. But an Atomist cosmogony could be associated, in Plato's mind, with what is for him the complementary feature of the common error: the lack of spontaneous, or 'voluntary', movement away from the surface of the earth (for this terminology see esp. p. 7 n. 11 above).

For Simplicius is right in seeing that, in their belief in the spontaneous or 'natural' movement of earth and fire in opposite directions, Plato and Aristotle make common cause against Democritus. Simplicius' error—the error of the professional historian—is to want to restrict Plato's

criticism to a named thinker, when in fact Democritus can be included, if at all, only indirectly, as part of the 'common error'.

(vi)

I return therefore to the text of the *Timaeus*. If we agree to associate Plato's 'common error' with the belief of 'the majority' in the *De caelo*, then how do we explain the image of the 'cosmic traveller' in the continuation of Plato's argument?

Plato tells us that the cosmic traveller will call the same part of the central body 'up' and 'down' in turn (63A2-4). Now obviously this use of 'up' and 'down' is not the same as the belief whereby 'up' and 'down' are two opposite places which 'divide the whole between them' (62C5-8).

1. In the image of the cosmic traveller, the same part of the central body is called 'up' and 'down' in turn.

2. In Plato's opening text, 'up' and 'down' provide a fixed and permanent division of the whole into 'opposite places'.

This difference is most simply explained as the difference between a spherical and a non-spherical universe. The cosmic traveller, or so I have argued, walks around the circumference of a spherical earth, suspended at the centre of a spherical universe. As he does so, he calls the same part of the central body 'up' and 'down' in turn. The cosmic traveller cannot therefore be identified with the adherents of the 'common error', who to judge from the *De caelo* do not inhabit a spherical universe, and who would therefore not agree that the earth, or part of the earth, could be both 'up' and 'down'.

But equally the cosmic traveller is not an exponent of Plato's new and corrected vocabulary. Quite the contrary, it is the terminology of the cosmic traveller which points to the impossibility of using 'up' and 'down' consistently to describe the parts of a spherical universe, and so to the need for Plato's correction (63A6ff.). From this point of view, the inconsistency in the terminology of the cosmic traveller is no more than the necessary negative condition for Plato's own positive account of 'heavy' and 'light' and of 'up' and 'down', which is to follow.

Who then is the cosmic traveller? He is not one of the adherents of the 'common error' (62C5-8); and he is not an exponent of Plato's new and corrected terminology (63A6ff.).

He is, I would suggest, an interesting, and a necessary, half-way stage. The reaction of the cosmic traveller, I would suggest, is the reaction of anyone who has been forced to leave the old hemispherical universe, with the sky 'above' and the earth 'below', and who has been made to enter the new, spherical universe with a central, spherical earth, but who has

not as yet thought out, or been persuaded to accept, the revised 'directional' vocabulary of the *Timaeus* or of the fourth book of the *De caelo*.

Thus the cosmic traveller does not describe the centre as always and only 'down', as Aristotle will do (*De caelo* iv 1, 308a14ff.). Still less does he use 'up' and 'down' to describe the movement of an element away from, or towards, its parent body (*Tim.* 63E3-7). The cosmic traveller divides the earth itself into 'up' and 'down', depending purely upon his own position on the surface of the globe; hence the paradox that, as he travels around the circumference of the earth, he will call the same part 'up' and 'down' in turn (63A2-4).

(vii)

Hence the interest of the *Phaedo*. For the terminology of the 'cosmic traveller' in the *Timaeus* is essentially the same as the terminology which Plato himself had used in the *Phaedo*, in describing the workings of Tartarus.

The waters of Tartarus move 'up' and 'down' (112B3; cf. 111E4), i.e. from our hemisphere to the hemisphere opposite our own. When the waters of Tartarus withdraw from our hemisphere to fill the rivers of the far hemisphere, they withdraw to 'the place that is called below' (τὸν τόπον τὸν δὴ κάτω καλούμενον, 112C1-2).

This, I would suggest, is the same as the terminology of the 'cosmic traveller' in the *Timaeus* (63A2-4), with the difference only that in the *Phaedo* there is no change of position. In the *Phaedo*, the point of view of narrator and reader remains that of our world or 'hollow', with the result that only one hemisphere, the hemisphere which we live on, is 'up', and the hemisphere on the other side of the earth is 'down'. But if the cosmic traveller of the *Timaeus*, or the narrator of the *Phaedo*, had to walk around the surface of the earth in the *Phaedo* would his verdict be any different from the verdict which the cosmic traveller will give in the *Timaeus*?

That of course is an unreal question; but I am not sure that the implication is untrue. The terminology of the *Phaedo* is not the terminology of the 'common error' in the *Timaeus*. 'Up' and 'down' in the *Phaedo* are not 'opposite places which divide the whole between them' (cf. *Tim.* 62C5-8). For Plato specifically recognises that the rivers from one hemisphere cannot pass beyond the centre, since in that case they would be flowing 'uphill' in the hemisphere opposite to their own (cf. ἄναντες, 112E2). The use of the same 'directional' adverb for *either* hemisphere shows that the narrator is conscious of the 'relativity' of a directional vocabulary in the description of a spherical earth.

Hence, I would suggest, the nuance of the particle in the expression τὸν τόπον τὸν δὴ κάτω καλούμενον (112C1-2). The particle has the nuance

which it 'often' has, when it 'denotes that words are not to be taken at their face value, objectively, but express something merely believed, or ironically supposed, to be true'. Denniston's definition (*Greek particles* 234) exactly fits the context of the *Phaedo*: the narrator knows, and expects his reader or listener to recognise, that the place 'called below' is so exclusively from the point of view of the upper hemisphere.

(viii)

This conclusion does not mean that Plato anticipates in the *Phaedo* the positive analysis of 'up' and 'down' which he will put forward in the *Timaeus*.

Morrison runs together two quite different points when, in the article I have quoted, he tells us, p. 114:

'If Plato was suggesting in the *Phaedo* the very important and novel idea that in a spherical universe "up" and "down" are not absolute, it is strange that he should merely hint it once in an off-hand phrase. In the *Timaeus*, in connexion with the universe, he deals with the matter at some considerable length.'

If the 'considerable length' of Plato's enquiry in the *Timaeus* covers the whole of the analysis of weight and direction (to 63E8), then it includes two quite different parts. The first (except for Plato's belief in a spherical universe, cf. pp. 24-7 above) is merely negative and adversative; the second is positive and expository. It would indeed be perverse to see in a single particle of the *Phaedo* an anticipation of Plato's new and positive analysis of direction and weight (63A6-E8); but it would be perfectly natural to see in the expression I have quoted from the *Phaedo* (112C1-2) a recognition of the point which underlies the earlier part of Plato's analysis in the *Timaeus* (62C8-63A6): the impossibility of using 'up' and 'down' in the old 'absolute' sense for the description of a spherical earth, suspended at the centre of a spherical universe.

(ix)

Significantly, the perspective of the *Phaedo* and of the earlier part of Plato's analysis in the *Timaeus* is the same as the perspective adopted by Aristotle in the earlier books of the *De caelo*.

Aristotle's criticism of Pythagorean ideas of a right and left hand to the universe leads to a discussion of 'upper' and lower' (*De caelo* ii 2, 284b6ff.; cf. p. 21 n. 30 above). Aristotle concludes initially (285b14-25) that the pole in our hemisphere is 'down', and that the pole in the hemisphere away from us is 'up', since it is in the far hemisphere that the movement of the fixed stars will be seen from right to left. Although the

Pythagoreans did not themselves specify 'up' and 'down' in relation to the cosmos (esp. 285a25-6), their ideas on right and left, Aristotle tells us, would have led to the opposite result: that we are in the 'upper' hemisphere, and that people on the other side of the earth are living in the 'lower' hemisphere (285b25-7). And this, finally, is Aristotle's own view, if the calculation of right and left is determined by planetary movement (285b28-33).

It is true that neither the *Phaedo* nor Aristotle's criticism in book two of the *De caelo* wholly coincides with the paradox of the *Timaeus*, where 'up' and 'down' are applied successively to the same part of the central body (*Tim.* 63A3-4). That paradox is only incidental to the discussion in the *De caelo*, and it is only implicit in the presentation of the myth of the *Phaedo* (cf. δῆ, 112C2; ἄναντες, E2).

Nonetheless these three passages—the myth of the *Phaedo*, the cosmic traveller of the *Timaeus*, Aristotle's criticism of the Pythagoreans in book two of the *De caelo*—have in common an important feature: the abandonment of the earlier naïve description of the heavens as 'up' and of the earth as 'down', and the adoption of a relativist terminology, where 'up' and 'down' are used, in different ways, to describe, or to include, different parts of the earth itself.

(x)

Now this conclusion, and especially the addition of the passage from book two of the *De caelo*, will provide, as I believe, a useful perspective for reviewing both Plato's own positive theory of direction in the *Timaeus* and Aristotle's theory of direction in book four of the *De caelo*.

Nonetheless, in the short term, it may be thought that my introduction of the passage from book two of the *De caelo* does more harm than good. For it is precisely this passage which has lain at the root of the defective understanding which both Cornford and Taylor display of the image of the cosmic traveller in the *Timaeus*.

I have already criticised Cornford's interpretation of the image of the cosmic traveller: 'At any moment' the supposed traveller 'will think he is "on the top" of the body which is "beneath him"' (*Cosmology* 263 n. 2; cf. pp. 18-23 and p. 36 n. 7 above). This, as I have noted, is not at all what Plato says. Plato tells us that the cosmic traveller will call the *same* part of the earth at different times 'above' and 'below' (*Tim.* 63A2-4). On Cornford's interpretation, by contrast, the traveller is always 'on the top' of the body which is 'beneath' him. And that is precisely the implication of Aristotle's own theory of direction, as put forward in book four of the *De caelo*, in opposition to Plato's theory (iv 1, 308a13ff.).

From this point of view, one might take Cornford's interpretation of the cosmic traveller to be just one more unhappy instance of the historian's inability to distinguish between Aristotle's ideas and the ideas of Aristotle's predecessors.

But the truth is that the error goes much deeper than this, and that the confusion is much worse than may at first sight appear. For Cornford's account of the cosmic traveller is repeated from the interpretation which Taylor had given of the same passage (*Tim.* 62A2-4; *Commentary* 438). And Taylor's interpretation of the passage is repeated from an earlier section of his *Commentary* (p. 151), where Taylor attempts to take account of Aristotle's criticisms of the Pythagoreans in book two of the *De caelo* (cf. p. 20 n. 29 above).

In this earlier passage of his *Commentary* (p. 151), Taylor seeks to contrast Aristotle's own theory of 'up' and 'down', as put forward in the criticisms which Aristotle makes of the Pythagoreans (*De caelo* ii 2, 284b6ff.) with what Taylor conceives to be the 'more rational' account given by the cosmic traveller in the *Timaeus*. But both terms in this contrast have been hopelessly confused: (1) the theory which Taylor claims is Aristotle's own is little different in principle from the theory which in book two of the *De caelo* Aristotle claims to *share* with the Pythagoreans; while (2) the 'more rational' theory which Taylor attributes to the cosmic traveller of the *Timaeus* is identical in its implication to the distinctively Aristotelean theory of direction, put forward in book four of the *De caelo*, in *opposition* to the theory of the *Timaeus*.

I take both points in turn.

In book two of the *De caelo* Aristotle presents the Pythagorean belief in a 'right' and 'left' to the universe as implying a division into an 'upper' and a 'lower' hemisphere. Aristotle's disagreement with the Pythagoreans hinges not on this principle, but solely on the practical application of the principle: which hemisphere is 'above', and which is 'below'? The movement of the fixed stars leads Aristotle to reverse the implication of the Pythagorean belief, and to have our own hemisphere as 'lower'; at the same time, he admits that the movement of the planets would yield the same result as that implied by the Pythagorean belief (*De caelo* ii 2, 284b6-286a2). Clearly therefore Aristotle here shares the principle which he claims is implicit in the Pythagorean belief (the earth, and the cosmos, have an 'upper' and a 'lower' half); such disagreement as there is centres on the application of the principle.

Quite different is the 'absolute' theory of direction adopted by Aristotle in book four of the *De caelo* as a consequence of (or more strictly as a necessary condition for) his own theory of 'absolute' weight. In this theory, 'up' and 'down' are 'absolute' directions, determined by the cir-

cumference being only and always 'up' and by the centre being always and only 'down' (*De caelo* iv 2, 308a13ff.; cf. iv 4, 312a3ff.).

This latter is the theory which Taylor attributes to the cosmic traveller of the *Timaetus*, *Commentary* 151: 'What we call up means simply the direction from the centre outwards ...'. And this is the theory which Cornford has chosen to repeat in his own account of the cosmic traveller, *Cosmology* 263 n. 2: 'At any moment' the supposed traveller 'will think he is "on the top" of the body which is "beneath him".' The implication of Cornford's formula is that centripetal movement is invariably movement 'downwards'. The implication of Taylor's formula is that centrifugal movement is invariably movement 'upwards'. The two formulae together therefore correctly represent the consequence of Aristotle's own theory, in book four of the *De caelo*, where the centre is always and only 'down', and where the circumference is always and only 'up'.

This confusion in Taylor's reading of the texts is compounded by two specifically Taylorean errors: the influence of Whitehead, and the identification of what Plato writes in the *Timaetus* with the beliefs of an otherwise unknown fifth-century Pythagorean. Again I take both points in turn.

The influence of Whitehead. The idea that centrifugal movement should be movement 'upwards' seems to Taylor 'more rational' than the view which divides the universe itself into an 'upper' and a 'lower' half, and Taylor therefore ascribes the 'more rational' idea to Plato and the less rational idea to Aristotle because, faithful to the intuitions of Whitehead in things both great and small, he adopts the perspective of *The concept of nature* (pp. 17ff.) whereby Aristotle's scientific ideas are inferior to those of Plato.

The Pythagorean 'Timaetus'. This conclusion is then neatly confirmed, for Taylor, by the passage in book two of the *De caelo*. For since the views of Plato in the *Timaetus* are merely those of the fifth-century Pythagorean 'Timaetus', the 'more rational' theory can be happily *opposed* to the theory which Aristotle himself adopts in his criticism of the Pythagoreans in book two of the *De caelo*.

But the truth is that the two ideas which Taylor seeks to contrast (*Commentary* 151) are both taken from Aristotle. (1) The 'more rational' view is not a Pythagorean view at all, but is identical in its implication with Aristotle's own theory of 'absolute' direction, as put forward in book four of the *De caelo*. (2) The supposedly less rational view is Aristotle's re-writing and correction of a Pythagorean view: a 're-writing', since Aristotle tells us specifically that the Pythagoreans did not in fact relate the opposition of 'up' and 'down' to the cosmos. Aristotle has himself coaxed the Pythagoreans along in that direction, in order to provide a foil for his own ideas in book two of the *De caelo*.

Altogether therefore, in these two pages of Taylor's *Commentary* (pp. 151 and 438), we find neatly encapsulated the worst and the most persistent errors which haunt Taylor's approach to the interpretation of the *Timaeus* as a whole: his slavish deference to Whitehead, his obstinate identification of the views which Plato puts forward in the *Timaeus* with the theories of an otherwise unknown fifth-century Pythagorean, and finally his ignorance of Aristotle, coupled—paradoxically—with his inability to escape from Aristotelean ideas in attempting to uncover the history of ideas, prior to Aristotle.

And yet the very complexity of Taylor's misunderstanding gives his whole interpretation a peculiar persuasiveness, almost a momentum of its own: so much so indeed, that even Cornford shrinks from unravelling the whole tangled skein of misinterpretation and of misassumption, and is happy to repeat Taylor's conclusion in a form that is only the more dangerous because, in the absence of any reference to Taylor, the casual reader of Cornford's *Cosmology* can have no idea of the intellectual morass from which the idea has been taken; while Cornford himself, no doubt bemused by the kaleidoscopic shift of quotation and assumption in Taylor's *Commentary*, and tempted perhaps by the conceptual clarity which even in this hideously mis-shapen context still clings to Aristotle's theory of 'absolute' direction, neglects to look again at the words in the text before him, and fails therefore to see that the consequences of the idea which he has chosen to repeat from Taylor are quite blatantly at odds with what Plato has in fact written in the *Timaeus*.

(xi)

I return to sanity and to the light of day. I have so far sought to establish two points.

First, the assumption of the 'common error' of the *Timaeus* and the belief of 'the majority' in book four of the *De caelo* are probably identical (cf. *Tim.* 62C5-8; *De caelo* iv 1, 308a17-29): the earth lies below a hemispherical firmament; the earth therefore is 'down' and the sky is 'up'; and in this sense therefore "'up" and "down" divide the whole between them'.

A different, and opposed, view of the universe may be found in a number of passages: the myth of the *Phaedo*, the cosmic traveller of the *Timaeus*, Aristotle's correction of the Pythagoreans in book two of the *De caelo* (cf. *Phaedo* 111C4-112E3; *Tim.* 63A2-4; *De caelo* ii 2, 284b6ff.). These three passages are not identical, but they have in common the abandonment of the earlier naïve description of the sky as 'up' and of the earth as 'down'. All three passages adopt instead a relativist terminology, where

'up' and 'down' are used, in different ways, to describe, or to include, different parts of the earth itself.

The disjunction between the ideas in these two sets of passages provides the historical perspective needed for an understanding of the difference between Plato's 'relativist' theory of direction in the *Timaeus*, and Aristotle's own 'absolute' theory of 'up' and 'down' as put forward in book four of the *De caelo*.

Aristotle claims (*De caelo* iv 1, 308a22ff.) that when 'the majority' are confronted with a spherical universe, their view will be the same as his own: the circumference will be 'up' and the centre will be 'down'.

But this is not in fact at all what happens in the *Timaeus*. When the cosmic traveller is allowed to walk round the central body (63A2-4), his supposition is not at all (as both Cornford and Taylor believe) that the whole of the earth is 'down', and that only the circumference above his head is 'up'.

The cosmic traveller does not anticipate the Aristotelean belief. What the cosmic traveller in Plato's *Timaeus* has in fact done is divide the central earth itself into an 'upper' and a 'lower' part. This is essentially what Plato himself had done in narrating the myth of the *Phaedo*. And this is what Aristotle will do in correcting and adapting Pythagorean ideas in book two of the *De caelo*.

What we learn therefore from these three passages is that neither Plato's own positive theory in the *Timaeus* nor Aristotle's theory in book four of the *De caelo* is identical with a simple abandonment of the earlier belief, which both Plato and Aristotle allude to, in a hemispherical universe where 'up' and 'down' divide the whole between them (cf. *Tim.* 62C5-8).

The traditional terminology can no longer be sustained, once the earth is visualised as a free-swinging globe in the centre of a spherical universe (as it is in the *Timaeus* and in book two of the *De caelo*), or even more simply, once it is visualised as having another side like our own (which is all that need be implied in the myth of the *Phaedo*). The immediate reaction, in either case, is to call one hemisphere, or one part, of the earth 'up' and the other 'down'. And from that point on more than one path is open. Plato adopts a 'relativist' theory of direction, in so far as 'up' and 'down' are determined by, and are purely relative to, the movement of an element towards or away from its parent body. Aristotle may be said to adopt an 'absolute' theory, in book four of the *De caelo*, since he there proposes to treat the centre as 'down' and the circumference as 'up', independently both of the position of the observer and of the movement of the elements (since in Aristotle's theory 'place' is prior to the 'natural' movement of a body towards that place).

But for all Aristotle's pretensions to be merely sanctioning the majority view, his definition is as much an innovation as is Plato's own. The only view which is not obviously innovatory is the view underlying the discussion in book two of the *De caelo* and adopted by Plato himself in the *Phaedo* and by the cosmic traveller in the *Timaeus*; this view is rather to be seen as a spontaneous reaction to the abandonment of the old view of a hemispherical universe, where up and down are 'absolute' divisions in the sense that they are taken for granted as a fixed and permanent division of the universe into 'opposite places'. But that reaction does not in itself anticipate either Plato's relative theory, nor Aristotle's absolute theory—'absolute' in a new and conscious sense, which is far from being the obvious and inevitable adaptation of the old view, which Aristotle would have us think it is.

(xii)

I summarise briefly. We can distinguish a number of clearly separable steps in the use of 'up' and 'down' preceding the analyses of Plato in the *Timaeus* and of Aristotle in book four of the *De caelo*.

The opinion of 'the majority' in the *De caelo* is apparently the same as that of the 'common error' in the *Timaeus*. The earth lies below a hemispherical sky: the earth is 'down' and the sky is 'up', and in this sense 'up' and 'down' divide the whole between them.

This picture of the universe is replaced, in the *Phaedo*, by a central earth that is spherical, or roughly spherical, in shape. 'Up' and 'down' attach to opposite hemispheres, but with implicit recognition of the arbitrariness whereby 'our' hemisphere is 'up'.

Aristotle in book two of the *De caelo* adopts a similar perspective: opposite poles are 'up' and 'down', and by different criteria the same pole will be both 'up' and 'down'.

This is the point of view illustrated by the cosmic traveller in the *Timaeus*, with only the refinement that for the cosmic traveller each part of the earth's surface is 'up' and 'down' in turn.

Plato's own theory of direction continues this relativistic approach: 'up' and 'down' are determined by the movement of earth and fire each towards its parent element, so that centripetal movement is 'down' for earth and 'up' for fire, while centrifugal movement is 'down' for fire and 'up' for earth.

Aristotle, in book four of the *De caelo*, adopts an 'absolute' theory: not, as he would have us believe, a simple return to the original naïve view; but a theory whereby 'up' and 'down' are attached to the opposition of circumference and centre which Plato had established in the *Timaeus*. The circumference is 'up' and the centre is 'down'.

(xiii)

This development does a great deal to clarify the ambivalence in Aristotle's criticism of Plato on the question of direction and weight, in the pages of the *De caelo* which I have already analysed in the main body of my essay (ch. IX § 3, pp. 185-91 above).

Aristotle rather scornfully opposes Plato's account of direction to what 'the majority' believe (*De caelo* iv 1, 308a17ff.), on the ground that Plato has abandoned an 'absolute' view of 'up' and 'down'. And yet in almost the same breath Aristotle groups Plato with those who have failed to recognise that fire will move upwards by nature, and who have failed therefore to recognise the existence of a body which is light absolutely (*De caelo* iv 2, 308b12ff.; cf. iv 4, 311b13ff.). On the first point, Plato supposedly flies in the face of common experience, while on the second point he has fallen victim to the error common to all Aristotle's predecessors.

And yet the truth, historically, is rather the reverse. On the first point, the analysis of direction, Plato is closer to the earlier view than Aristotle is; while on the second point, recognition of a body which is light absolutely, Plato is closer to Aristotle than any other of Aristotle's predecessors.

For Aristotle has in effect obliterated the distinction between the two views which are represented in the *Timaeus* by what I have called the common error and the cosmic traveller. On Aristotle's view of history, there is, so to speak, a single one-step advance from the belief of 'the majority' to Aristotle's own belief: in both cases, 'up' and 'down' divide the whole between them, with the difference only that 'the whole' is no longer the earth surmounted by a hemispherical sky, but has become instead a spherical firmament enclosing a spherical and free-swinging earth.

But from the *Phaedo* and from the *Timaeus* we learn that there was an in-between stage, where the spherical earth was not treated as being 'down' (whether because it is at the centre or because it is beneath the celestial hemisphere), but was itself divided into 'up' and 'down'. Plato's analysis of direction can be seen, historically, as directly relating to this adaptation of the common error, in so far as on Plato's theory the earth is again both 'up' and 'down': 'down' relatively to the movement of earth, but (at least by implication) 'up' in relation to the movement of fire. From this point of view, it is Plato who is closer to the earlier view, and Aristotle who innovates in restoring an 'absolute' use of 'up' and 'down', even within a spherical universe.

On the other hand, in his theory of the elements, it is Plato's theory which provides the essential innovation that will be adopted by Aristotle

(an innovation at least with regard to ancient Atomism): for it is Plato who provides for the voluntary movement of fire to the circumference no less than of earth to the centre, even if (from Aristotle's point of view) Plato conceals his innovation by continuing to employ, for this distribution of the elements, the traditional vocabulary, whereby movement 'upwards' is 'involuntary' or (in Aristotle's terms) contrary to nature.

Childishly simple though these concepts may seem, they therefore have a good deal to tell us of the history of philosophy, for it is in his criticism of Plato's theory of weight and of direction that we can see Aristotle's true weakness as an historian of philosophy. Aristotle's failure to repeat accurately the ideas of his predecessors is a failure of practice rather than a failure of policy; and a failure which I believe has been a good deal exaggerated by recent writers. Aristotle's true weakness as an historian is to be seen rather in his judgement on the development of ideas, on the relations of earlier thinkers, even on the value of his own achievement.

Thus in the present instance Aristotle has virtually inverted the historical reality. Plato is closer to his predecessors than he is to Aristotle in his 'relativist' ideas of direction; and closer to Aristotle than to his predecessors in his theory of the distribution of elements. But Aristotle's preoccupation with his own theory of absolute weight and of absolute direction leads to exactly the opposite perspective: Plato's theory of direction is an aberration which flies in the face of earlier ideas; while Plato's innovation in his theory of the distribution of elements is concealed from Aristotle, precisely because that innovation is still clothed in an adaptation of the traditional terminology, which Aristotle has failed to recognise as such.

THEOPHRASTUS AND THE TWO 'LOGOI'

(i)

I have deliberately left aside a number of complications which might have intruded into my analysis of the two *logoi* which Theophrastus employs in his criticism of Plato (*cf.* pp. 245-57 above).

For example, I argued (pp. 252-3 above) that we cannot extract two *logoi* exclusively from the correlation between size and ease or difficulty of movement ('the larger body is more difficult to move', 'the smaller body is easier to move'), because the *logos* which Theophrastus himself refers to (*Dox.* 526.12-13) is founded on the correlation of size and speed: 'the larger quantity <of earth> travels from above to here more quickly.'

The reader may however think to re-introduce this argument for what I have claimed as the second *logos*: would it not be possible to extract two *logoi* exclusively from the alignment of size and speed, by the same expedient of supposing that there is one *logos* for a larger quantity and a second *logos* for the smaller quantity?

This seems to me unlikely. The expression 'the former and the latter *logos*'—especially in its emphatic form, 'both the former *and* the latter' (καὶ οὗτος καὶ ἐκεῖνος, *Dox.* 526.11)—would not easily apply to two parts of what are in effect a single formula (whether the correlation of size with speed, or the correlation of size with ease and difficulty of movement). Equally, it seems to me that the general content of the passage is much more likely to require that 'the former *logos*' should refer to the criterion of weight in Plato's theory: ease and difficulty of movement. The correlation of size exclusively with speed would be only very indirectly relevant as a criticism of Plato's theory.

(ii)

It is true that in attempting to introduce the Platonic criterion for a *logos* which will 'apply' at the circumference and which will not apply at the centre (or *vice versa* for earth), we face the difficulty of needing to correlate size with ease or difficulty of movement both for the body which we move away from its proper place and also for a body which has to be thought of as moving towards its proper place. The larger quantity of fire is more difficult to move away from the circumference: but in what sense does this *logos* not apply for fire which is measured at the centre?

A possible solution would be to claim that the idea that the former *logos* will not 'apply' at the centre, for fire (cf. ἐφαρμόσουσιν, *Dox.* 526.11), reflects precisely this difficulty: the implication would be that there is no obvious way of relating Plato's criterion, of ease or difficulty of movement, to an element which is already outside its proper place.

But that explanation is hard to match with the criterion of speed: for here the implication is plainly that we *can* measure the speed of an element, but with the *opposite* result at centre and at circumference, i.e. if the element is moving towards or away from its natural place. I have therefore preferred to suppose that Theophrastus has extended the notion of resistance in line with his conception of speed, in the way that I have indicated pp. 251-2 above: (1) it is more difficult to move a large quantity of fire away from the circumference, and the larger quantity will therefore move, or be moved, more slowly; (2) a larger quantity of fire moves away from the centre more quickly than a smaller quantity, and Theophrastus supposes that it would therefore be easier to move.

The *logos* which associates size with ease or difficulty of movement will then 'apply' at the circumference: the larger quantity of fire is more difficult to move. It will not 'apply' at the centre: the larger quantity of fire would there be easier to move.

(iii)

It will be true that on this interpretation of the way in which 'the former *logos*' will not apply, to the measurement of fire at the centre or of earth at the circumference, Theophrastus will have introduced a different notion of resistance from that which I have suggested may be implicit in the text of the *Timaeus* (cf. pp. 70-5 and p. 252 n. 12 above).

In the *Timaeus*, I have suggested, there may be the implication that the larger quantity of fire, for example, which is *more difficult* to move away from the circumference would equally require a greater expenditure of effort to keep it from returning to its natural place. But when Theophrastus writes that 'the former *logos*' will not apply at the centre, for fire, his meaning, I have argued, will be that the larger quantity of fire would be *easier* to move away from the centre, with the converse implication for earth, that the larger quantity would be *easier* to move away from the circumference: in effect, therefore, just the opposite of the notion of resistance which I have suggested may be implicit in Plato's own text.

But the existence of this anomaly is more an argument in favour of my interpretation than the reverse. Theophrastus has in effect filled in the implication in Plato's system (the measurement of fire at the centre, and of earth at the circumference) with a notion of 'dislodgement' which finds

no foothold in the text of the *Timaeus* (where Plato deals exclusively with the effort required to drag a larger or a smaller quantity of either element *away from* its parent body), and which is instead deduced from Aristotle's use of speed as a (secondary) criterion of weight.

It is a major defect in Taylor's interpretation that he adopts the idea of resistance which we find by implication in Theophrastus, and makes no attempt to consider what other ideas of resistance might be better adapted to Plato's own expression of his theory (see esp. pp. 70ff. above).

(iv)

A further complication: at first sight it may seem that a simpler way to divide the two *logoi* would be according to quantity, with the two criteria of speed and of ease or difficulty of movement repeated within either *logos*: (1) a larger quantity is more difficult to move, and moves more slowly; (2) a smaller quantity is easier to move, and moves more quickly.

But in that case we do not have, in the positive expression of either *logos*, the correlation of speed and size which in the Aristotelean system attaches to natural movement, whereby the larger quantity of either element moves more quickly. And yet this is the correlation which is implied, I have suggested (pp. 253-4 above), by Theophrastus' assertion that the larger quantity of fire is lighter (*Dox.* 526.10), and this is the correlation which is stated directly when Theophrastus writes that the larger quantity of earth moves from above to below more quickly (*Dox.* 526.12-13). It would seem unnatural therefore for this correlation not to appear in the positive expression of either *logos*.

In seeking to remove this anomaly, we may think to state the two *logoi* in the form: (1) the larger body is more difficult to move, and moves more quickly; (2) the smaller body is easier to move, and moves more slowly.

But this division occasions a difficulty from another quarter, if we reflect upon the direction of movement now implied by the two criteria of speed and of ease or difficulty of movement: (1) the larger body is more difficult to move in one direction, and it moves more quickly in the *opposite* direction; (2) the smaller body is easier to move in one direction, and it moves more slowly in the *opposite* direction. I find it awkward, if not impossible, to suppose that a single *logos* would embrace the movement of an element in opposite directions.

(v)

It seems to me simpler, therefore, to arrange the division of ideas the other way round, so to speak, in such a way that the difference of quanti-

ty is repeated in either *logos*, and that we divide the two *logoi* initially according to the two criteria of speed and of ease or difficulty of movement, in the way I have indicated, so that the two *logoi* appear in the form: (1) the larger quantity is more difficult to move, the smaller quantity is easier to move; (2) the larger quantity moves more quickly, the smaller quantity moves more slowly.

The direction of movement is now the same for different quantities of either element, within each *logos*, and the difference in direction of movement, for the different quantities of each element, falls between the two *logoi*: (1) the 'former *logos*' is true for different quantities of fire which we seek to move away from the circumference, and for different quantities of earth which we seek to move away from the centre; (2) the 'latter *logos*' is true for different quantities of fire which move towards the circumference, and for different quantities of earth which move towards the centre.

The directions are of course reversed when either *logos* does *not* apply: (1) the larger quantity of fire or of earth is easier (not more difficult) to move away from the centre and away from the circumference respectively; (2) the larger quantity of fire or of earth moves more slowly (not more quickly) away from the circumference and away from the centre respectively.

In effect, Theophrastus adopts the alignment of size with speed and with ease or difficulty of movement as the content of the two *logoi*, and his complaint is that this alignment cannot apply to the measurement of either element in the same way at the centre and at the circumference.

(vi)

Not only is this arrangement of the two *logoi* conceptually the simplest; it is also the arrangement which answers most easily to what we may suspect to have been the probable historical origin of the two *logoi* in Theophrastus' own beliefs on the nature of movement.

For the two *logoi* spring ultimately from the distinction, in Aristotle's philosophy, between natural movement and movement by constraint.

Thus the Aristotelean *logos* (the 'latter *logos*'), whereby the larger quantity of either element moves more quickly, corresponds to 'natural' movement. This *logos* therefore 'applies' to the movement of fire towards the circumference and of earth towards the centre, and does not 'apply' to the movement of either element in the opposite direction.

The Platonic *logos* (the 'former *logos*'), whereby the larger quantity of either element is more difficult to move, corresponds to movement 'by constraint'. This *logos* therefore 'applies' to the movement of fire away

from the circumference and of earth away from the centre, and does not 'apply' to the movement of either element in the opposite direction.

This division of ideas is not of course accidental: it is directly the result of the way in which Theophrastus (or so I have argued) has extended Plato's simple theory of the resistance of fire at the circumference and of earth at the centre to include the explicit measurement of either element in a place other than its 'own'.

For in constructing this extension to Plato's theory Theophrastus has used the concept of natural movement, and *not* the concept of movement by constraint. Theophrastus (so I have argued) concludes that since the larger quantity of earth and of fire moves more quickly away from the circumference and away from the centre respectively, therefore either quantity would be the easier to move in this direction.

And hence the contradiction whereby the Platonic *logos* will 'apply' at the centre for earth and at the circumference for fire (since in both cases it is aligned with movement 'by constraint') and will 'not apply' at the circumference for earth and at the centre for fire (since in these two cases it is aligned with 'natural' movement).

Hence too the difference in direction of movement, between the two *logoi*. The Aristotelean *logos* employs the correlation with 'natural' movement, and will therefore 'apply' to the movement of fire towards the circumference and of earth towards the centre. The Platonic *logos* employs the correlation with movement 'by constraint', and will therefore 'apply' to the movement of fire away from the circumference and of earth away from the centre.

When either *logos* does not 'apply' it is because these associations have been reversed. The Aristotelean *logos* will not 'apply' to the movement of fire away from the circumference, nor to the movement of earth away from the centre, i.e. to movement 'by constraint'. The Platonic *logos* will not 'apply' to the movement of fire away from the centre, nor to the movement of earth away from the circumference, because in either case it has been taken by Theophrastus to correspond to 'natural' movement.

Once these associations have been made explicit, it is reasonably clear that no other arrangement of the two *logoi* would answer so easily and so simply to the two categories of movement fundamental to Aristotle's physical philosophy, and familiar therefore to Theophrastus: natural movement and movement by constraint.

(vii)

My conclusion is that the two *logoi* are: (1) the larger quantity is more difficult to move, the smaller quantity is easier to move (what I have

called the Platonic *logos*); (2) the larger quantity moves more quickly, the smaller quantity moves more slowly (what I have called the Aristotelean *logos*).

These two *logoi*, and their different application at centre and circumference, seem to me the simplest and the most natural interpretation of what is, on any showing, an extremely compressed passage.

For Theophrastus' expression of his ideas is here even more than usually elliptical; inevitably, the extremely abbreviated form of expression which he has chosen to employ means that precisely how we divide the various ideas that are afloat in this passage between the two *logoi* has to remain to some extent a matter of personal judgement. Provided that the content of the two *logoi* employs the correlation of size with speed and with ease or difficulty of movement, then any one of the alternative schemes that I have outlined could perhaps be adapted, *tant bien que mal*, to the over-all analysis that I have given of Theophrastus' criticism of Plato.

THE PARADOX OF RELATIVITY

(i)

I have argued that Plato's 'two' theories of weight in the *Timaeus* may be seen as an attempt to extend to heavy and light the idea of the *sensibilia* as dependent upon the conjunction of perceived object and percipient, an idea that Democritus had already applied to other sensible 'qualities', e.g. sweet and sour or hot and cold (see esp. ch. XV § 3, pp. 289ff. above).

It is instructive to compare with the later passage of the *Timaeus* (62C3-63E8) the form of argument which Theophrastus quotes from Democritus as serving to establish the *sensibilia* as relative to, and therefore in part dependent upon, the observer, *De sens.* 63 (DK 68A135):

'Proof that the objects of sensation do not exist by nature is their failure to appear the same to all sentient beings (ζῴοις).

'Thus what appears to us as sweet appears to others—<although it is> the very same thing—as sour; to others still as sharp; to others as acidic; to others as bitter: and so on with the other sensibles.'

The companion argument is fairly obviously designed to show that the same thing may affect the same percipient in different ways if the percipient himself changes.

'Another argument: the composition <of the elements> in the percipients themselves changes; their feelings (πάθη) change; their age changes: whence it is clear that the inner perception they acquire (φαντασία) is causally determined by the condition that they are in <—because the same object will appear differently to the same percipient at different times>.' (*De sens.* 64)

Plato pursues the same two arguments in the *Theaetetus*, with the difference only that colours are used in the way that differences of taste had been used by Democritus, namely to show how the same thing may appear differently to *different* observers at the same time, and that differences of taste are used to make the companion point, namely to show that the same thing may appear differently to the *same* observer at different times. (1) Thus the colours which Theaetetus sees will not appear the same to someone else (154A-B). (2) The wine which Socrates finds sweet when he is healthy seems to him bitter when he is ill (159B-E).

Purely for convenience, and for the sake of simplicity, I suggest that we take the example of flavours to show both (1) how it is that the same thing

may appear differently to *different* observers at the same time, as in Democritus' *first* argument, and (2) how it is that the same thing may appear differently to the *same* observer at different times, as in Plato's *second* argument. The same thing, wine, may appear sweet and sour (1) to *different* persons at the same time, and (2) to the *same* person at different times (and in different states, well or ill).

This pair of arguments would then appear to provide the obvious context, at least initially, for Plato's account, in the *Timaeus*, of the paradoxical inconsistency attaching to our use of the words 'up' and 'down', though the order of the two arguments is there reversed. (1) The same thing will appear differently to the *same* observer at different times: thus the man who walks around the central body will call the same part of the central body alternately up and down (*Tim.* 63A2-4). (2) The same thing will appear differently to *different* observers at the same time: thus centrifugal movement (to take only this example) will be 'down' for the person who measures fire at the circumference and 'up' for the person who measures earth on earth (63A6ff.). From this point of view, Plato's account of position in the *Timaeus* appears to follow precisely the two types of argument that Theophrastus attributes to Democritus in the *De sensibus*, and that Plato himself employs in the *Theaetetus*, in order to illustrate the paradoxical relativity attaching to our description of the objects of sense.

(ii)

This appearance of identity is however deceptive in a number of ways, of which the simplest is that in the *Timaeus* Plato's two arguments are not presented as bearing on the same object, or as possessing the same validity, as is the case if we join the arguments I have quoted from the *Theaetetus* and from the *De sensibus*.

Thus if I continue to join Democritus' *first* argument and Plato's *second* argument, but if I now reverse the order of the two arguments so as to conform to the order of arguments in the *Timaeus*, then in the case of sweet and sour the content of the paradox is the same for the single observer and for different observers: (1) the wine is sweet and sour for the *same* observer at different times (and in different states, well or ill), and (2) for different observers at the same time. But in the *Timaeus* the content of the paradox is different in the two cases: (1) in the first form of the paradox (63A2-4) the contrast lies between different parts of the earth's surface; (2) but in the second form of the paradox (63A6ff.) the contrast lies ultimately between centre and circumference.

From this point of view there is in the *Timaeus*, or so I have sought to argue (pp. 23-5, 30-4 and 62ff. above), a progression in Plato's

thought. (1) At first (63A2-4), the observer at the centre calls the same part of the central body 'up' and 'down' in turn: the usage of the one observer is *inconsistent* therefore. (2) But in the continuation of Plato's analysis (63A6ff.) 'up' and 'down' are determined by the movement of earth and fire away from, and towards, the parent body. In this context, Plato does not attempt to show that there is any inconsistency in the observation of the single observer who is stationed at the centre, or at the circumference. As I explained earlier, in this later part of Plato's analysis of direction the *inconsistency*, such as it is, lies *between* the usage of the two observers, at the centre and at the circumference, each of whom uses 'up' and 'down' *consistently* in relation to his own position.

In the *Timaeus*, therefore, the comparison between the two observers in Plato's analysis of weight and direction (63A6ff.) does not repeat the paradox of the cosmic traveller in Plato's initial analysis of direction (esp. 63A2-4): (1) there is no inconsistency attaching to the isolated perceptions of the observer at the centre or of the observer at the circumference; (2) the inconsistency, such as it is, that does exist between the perceptions of the two observers is not a simple repetition of the inconsistency attaching to the observations of the cosmic traveller.

This disparity between the two forms of paradox, that in the *Timaeus* and that in the *Theaetetus* or the *De sensibus*, affects radically the application of the paradox of relativity to heavy and light.

For the analysis of weight is attached exclusively to the later part of Plato's analysis of direction (63A6ff.). In this context therefore, for weight as for position, Plato does not attempt to portray the usage of the *single* observer as *inconsistent*. For the observer at the centre, the larger part of earth is heavy and moves downwards, and the smaller portion is light and moves upwards. For the observer at the circumference the same will be true for the comparison between a larger and a smaller quantity of fire. Again therefore the usage of either observer, taken on his own, is *consistent*, and the *inconsistency*, such as it is, lies *between* the comparison of earth at the centre and the comparison of fire at the circumference.

Thus according to the analysis of weight and of direction (63A6ff.), there is no ground for concluding that the *same* thing will appear both heavy and light to the *same* observer at different times, as is the case for 'up' and 'down' in the earlier part of Plato's analysis (63A2-4).

(iii)

But this difference, it may be said, is purely trivial. Admittedly Plato talks of two observers, at centre and at circumference, but in practice, it will be said, it makes no difference whether we suppose that there are two

observers, or whether we suppose that there is one observer who moves from centre to circumference.

And from this point of view we may think to reconstruct, for Plato's account of weight and of direction, in the second half of his analysis (63A6ff.), precisely the form of paradox that we have for sweet and sour, in the *Theaetetus* and in the *De sensibus*: the same thing will appear differently (1) to different observers at the same time, or (2) to the same observer at different times.

Thus centrifugal movement, to take only this example, will be 'down' to the person who measures fire at the circumference and 'up' to the person who measures earth at the centre, whether these are different persons or the same person.

From this point of view, the same thing (movement from centre to circumference) will appear differently ('up' and 'down') to different observers at the same time, or to the same observer at different times.

And from this we may think to construct the equivalent paradox for the opposition of heavy and light: the same thing (a large quantity of earth, for example) will appear differently ('heavy' and 'light') to different persons at the same time, or to the same observer at different times.

Now significantly this is precisely the interpretation which Taylor adopts of Plato's argument, and it is also precisely the conclusion of the criticism which Theophrastus brings against Plato in the *De sensibus* (cf. pp. 45-50 and 267-75 above). According to Theophrastus (*De sens.* 88), a large quantity of earth, which is heavy at the centre, would have to be light if measured at the circumference.

I have already argued at length that this cannot be Plato's intention (esp. pp. 56-9 above). But here the point to note is that this is not in fact the form of paradox which Plato provides in his account of weight and of direction (63A6ff.). Plato does say that the movement of earth, for example, away from the centre, and towards the circumference therefore, will be movement 'upwards' from the point of view of someone who stands at the centre and calculates the movement of earth. And he does also say that the movement of fire towards the circumference and away from the centre therefore will be 'down' for the person who stands at the circumference and calculates the movement of fire. From these two statements therefore we may think to construct the form of opposition that I have listed in the first section of this Note: the same thing (movement outwards from the centre) will be 'up' for the person at the centre, who measures the movement of earth, and 'down' for the person at the circumference, who measures the movement of fire. But this is not the form of opposition which Plato himself in fact supplies in the generalisation with which he first concludes his analysis of weight and direction

(63D4-E3, what I earlier called the 'alignment of opposites': for my earlier analysis see above pp. 35-9). For here Plato states that what is 'up' in one position (to take only this example) is the opposite of what is 'up' in the opposite position. In this form the paradox states not that the *same* thing has *different* designations for different observers, as in the arguments from the *Theaetetus* and from the *De sensibus*, but that *different*, or opposite, things have the *same* appellation: what is 'up' in one place (movement inwards, at the circumference) is the opposite of what is also called 'up' in the opposite place (movement outwards, for the observer at the centre).

The implications of Plato's choice of paradox, in the *Timaeus*, are far from having been exhausted. For the moment, I pause only to summarise the discrepancy that has arisen between (1) the paradox which Plato uses in the *Theaetetus*, and which Theophrastus records in the *De sensibus*, and (2) the paradox which Plato employs in the *Timaeus*. In the *Theaetetus* and in the *De sensibus*, two arguments are employed to demonstrate the dependence of the *sensibilia* upon the conjunction of perceived object and percipient: the same thing appears differently to the *same* percipient at different times, or to *different* percipients at the same time. Thus wine appears sweet to one person and sour to someone else, or to the same person at different times (to make the same example answer to both arguments): the conclusion drawn from this is that wine is not in itself sweet or sour; with the further conclusion that 'sweet' and 'sour' arise only when something which is not itself sweet or sour is brought into contact with a sensible percipient. If Plato had employed this same argument in the *Timaeus* then the conclusion would have been that the same thing (which is not itself 'heavy' or 'light') appears *both* 'heavy' *and* 'light' to different observers, or to the same observer at different times: a larger quantity of fire which appears heavy to the observer at the circumference seems light to the observer at the centre. This *is* the conclusion which Taylor attributes to Plato, but it is *not* the conclusion which Plato himself offers in the *Timaeus*. For although the context of Plato's discussion in the *Timaeus* evidently does invite us to see heavy and light, no less than hot and cold, or sweet and sour, as dependent upon the conjunction of perceived object and percipient, nonetheless his analysis does not simply repeat the argument which had been used to support the equivalent conclusion in the *Theaetetus* and which is attributed to Democritus in the *De sensibus*. (1) Plato does not introduce at all, for weight, the paradox that the same thing appears differently to the *same* observer; this paradox is peculiar to the earlier part of Plato's passage, the analysis of direction only (62C3-A6, esp. 63A2-4). (2) And even in the analysis of weight and of direction (63A6ff.), Plato does not employ precisely the paradox that the

same thing appears *differently* to different observers: instead, Plato concludes in effect that *different*, or opposite, things appear the *same* to different observers. Evidently we are still supposed to see heavy and light as therefore in some way dependent upon the conjunction of perceived object and percipient, but we are not invited simply to transfer to the *Timaeus* the arguments of the *Theaetetus* and of the *De sensibus*: we are not invited to conclude that, just as in the *Theaetetus* and in the *De sensibus* wine which is sweet for one person is sour for another (if we take Plato's example to underly the flavours listed by Theophrastus), so also, in the *Timaeus*, a larger quantity of fire which is heavy at the circumference is light at the centre.

(iv)

Even so, the difference I have sought to underline between the form of paradox in the *Theaetetus* and in the *De sensibus*, and the form of paradox we find in the second part of Plato's analysis of weight and direction in the *Timaeus* (63A6ff.), may still be thought to be trivial. For it may well be thought that either form of paradox can be converted to the other, without any serious disturbance to the underlying idea, the 'relativity' of our sensible perceptions, and their dependence therefore upon the conjunction of perceived object and percipient.

To test this reaction, there are two obvious questions. (1) Under what conditions can the arguments of the *Theaetetus* or the *De sensibus* be adapted to yield the paradox which appears in the *Timaeus*? (2) Under what conditions is it possible to adapt the argument of the *Timaeus* to the arguments which Plato employs in the *Theaetetus* or which Theophrastus records in the *De sensibus*?

The *first* question: in the case of sweet and sour, the two forms of paradox are fairly obviously equivalent. The *Theaetetus* and the *De sensibus* provide the paradox that the *same* thing will appear differently to different observers at the same time, or to the same observer at different times: wine tastes sweet to Socrates when he is well, and sour to Socrates when he is ill. From this we may reasonably conclude that *different* things are given the *same* appellation by different observers at the same time, or by the same observer at different times: <vinegar, for example, tastes sour to Socrates when he is well, wine tastes sour to Socrates when he is ill>. (Here and throughout, the 'reconstructed' paradox is enclosed in angle brackets.)

I turn therefore to the *second* question: can we adapt the form of paradox in the *Timaeus* to the form of paradox in the *Theaetetus* and in the *De sensibus*?

At first sight, it may seem that we can: that the two forms of paradox are just as easily convertible for 'up' and 'down', though now we move in the opposite direction, so to speak. *Different* things in the *Timaeus* are given the *same* appellation by different observers: what is 'up' to the observer at the centre (centrifugal movement, for the measurement of earth) is the opposite of what is 'up' to the observer at the circumference (centripetal movement, for the measurement of fire). But Plato has also told us that movement towards the circumference, centrifugal movement therefore, is 'down' for the person who measures the movement of fire at the circumference. We may therefore conclude that in the *Timaeus*, as in the *Theaetetus* and in the *De sensibus*, the *same* thing will appear *differently* to different observers: <the direction which is 'up' to the observer at the centre (centrifugal movement, for the measurement of earth) is 'down' to the observer at the circumference (centrifugal movement, for the measurement of fire)>.

The unwary reader may therefore jump to the conclusion that the two forms of paradox are similarly convertible for 'heavy' and 'light'. *Different* things in the *Timaeus* are given the *same* appellation by different observers: what is 'heavy' to the observer at the centre (a large quantity of earth) is the opposite of what is 'heavy' to the observer at the circumference (a large quantity of fire). From this we may think it follows that, as in the *Theaetetus*, the *same* thing will appear *differently* to different observers: <what is 'heavy' to the observer at the centre (a large quantity of earth) is 'light' to the observer at the circumference>.

Once more we arrive at Taylor's interpretation, and at the criticism which Theophrastus makes of Plato in the *De sensibus*. And this coincidence, it seems to me, can hardly be accidental. Though so late in the day, I suspect we arrive here, in my final Note, at the innermost citadel of the interpretation of the *Timaeus* which I have sought to combat throughout my essay. In the argument I have just outlined, I suspect we see the reason why that interpretation flows so glibly from the pen of Taylor, why it is taken over so easily and so effortlessly by lesser men than Taylor,—perhaps even why Cornford fails to dissent from Taylor's interpretation, despite his care to dissociate himself from Taylor at many other points in his commentary. The traditional interpretation of the theory of weight in the *Timaeus*, I suspect has been adopted so often and so easily, precisely because it is seen as an obvious and an easy corollary to the form of paradox that had traditionally been used to demonstrate the relativity of the *sensibilia*, by Democritus, and by Plato himself in the *Theaetetus*.

For although Plato does not in fact write that, for 'heavy' and 'light' and for 'up' and 'down', the same thing will appear differently to dif-

ferent observers at the same time, or to the same observer at different times, his analysis does include two formulae which may seem to be tantamount to his saying exactly that.

Thus in his initial analysis of direction (62C3-63A6), Plato does say that the same part of the earth's surface will appear to the same observer at different times, 'up' and 'down'. The careless reader will fail to see that Plato tacitly disowns this conclusion in the analysis which he finally gives of weight and of direction (63A6ff.). Instead, the conclusion that 'up' and 'down' are in this sense purely relative terms will be presented as all of a piece with Plato's final definition, and that conclusion will be extended to include the opposition of weight, with the result that 'heavy' and 'light', no less than 'up' and 'down', are attached to the same object for different observers at the same time, or for the same observer at different times. (This is in fact how the paradox of the 'cosmic traveller' is presented by Stratton, in the 'summary' which he gives of Plato's theory in his edition of Theophrastus' *De sensibus*, pp. 205-6.)

Secondly, and even more seriously, Plato does claim, in his analysis of weight and of direction (63A6ff.), that *different*, or opposite, things appear the *same* to different observers at the same time. This formula can be seen as a simple consequence of the traditional paradox for the relativity of the *sensibilia* in the *De sensibus* and in the *Theaetetus*, whereby the *same* thing appears *differently* to the same observer at different times, or to different observers at the same time. And the obvious, and indeed barely conscious, reaction of the superficial reader is therefore to conclude that we can, so to speak, tread the path backwards, in the sense that, from the paradox of the *Timaeus*, we can at once pass to the paradox of the *De sensibus* and of the *Theaetetus*, and so to the traditional interpretation of the *Timaeus*. Plato tells us that *different*, or opposite, things appear the *same* to different observers at the same time. Therefore the *same* things appears *differently* to different observers at the same time, or to the same observer at different times. Therefore 'the body which is heavy in one region of the universe is light in another.' (For this formula, see p. 328 and p. 331 above.)

(v)

Now I have already argued that this conclusion is precluded by Plato's conception of weight as tied to quantity or number. If the larger quantity of earth is to be lighter (for the observer at the circumference), then it will no longer be the case that weight is determined by, or at least covariant with, the number of triangles (*cf.* esp. ch. XV § 3, pp. 289-99 above).

No less impossible, or so I have argued, is the form of paradox which results if we adopt the comparison, foisted onto Plato's analysis of weight

and direction by Taylor and by Martin (pp. 45ff. and 327ff. above), whereby we compare different elements: since the *same* thing appears *differently* to different observers at the same time, or to the same observer at different times, therefore earth which is heavier than fire at the centre will be lighter than fire at the circumference. This conclusion, I have argued, is impossible for Plato, since it requires us to compare directly the *two* kinds of resistance, the one whereby we drag one element *away* from its proper place, and the other whereby we seek to prevent the second element *returning* to its native body. Plato, I have argued, has no unified conception of 'force' or 'resistance' which would enable him to forego his conceptual dependence upon the use of a pair of scales, and so to compare directly these two kinds of movement (*cf.* esp. ch. XV § 5, pp. 304-11 above).

But these are, so to speak, the material objections to the traditional interpretation of the *Timaeus*. There is also a formal error in the 'conversion' of the paradox, which will be apparent if we return to look more closely at the various forms of paradox that I have proposed in relation to the text of the *Timaeus*.

In seeking to uncover the origins of Taylor's interpretation, I proposed, in the preceding section of this Note (p. 416 above), to convert the paradox of the *Timaeus*, what is 'up' at the centre is the opposite of what is 'up' at the circumference, to the form of paradox found in the *Theaetetus* and in the *De sensibus*, <what is 'up' to the observer at the centre is 'down' to the observer at the circumference>. This is in fact exactly how Taylor presents the opposition of direction when he writes that: 'Jules Verne's adventurers are shot *up* to the moon, but the "man on the moon" would think of them as *descending* on his planet' (*Commentary* 440; *cf.* pp. 57ff. above). But note that this is true only if we conceive of the direction of movement in abstraction from the nature of the moving body. For although it will be true, in the earlier part of Plato's analysis, that for the observer at the centre movement outwards is movement 'upwards', and that for the observer at the circumference this same movement is movement 'downwards', nonetheless once we take into account the requirement of Plato's final definition (63E3-7) then this nomenclature will be correct, only if the observer at the circumference measures fire, and if the observer at the centre measures earth. For according to the terms of Plato's final definition earth moves 'upwards' whenever it is moving away from the centre, and 'downwards' whenever it returns to its native element: a *single* body therefore, in the course of a trajectory from centre to circumference, does *not* exemplify movement in two directions, 'upwards' away from the centre and 'downwards' towards the circumference: earth in moving from centre to circumference

and fire in moving from circumference to centre, both alike move *only* 'upwards'. In this *latter* sense, therefore, it will *not* be possible to 'convert' the paradox of the *Timaeus* into the form of paradox used in the *Theaetetus*, even for direction. For once we take into account the requirement of Plato's final definition it will *not* be the case that the 'same' movement, i.e. the movement of a single body, ever appears 'differently' to the same observer at different times, or to different observers at the same time.

Now this distinction is crucial when we turn to construct an equivalent paradox for the opposition of weight.

The 'unity' which underlies the opposite 'names' of 'up' and 'down' is not supplied by Plato's text. It is supplied by the reader. For when we 'convert' the paradox whereby *different* things appear the *same* ('what is "up" in the one place is the opposite of what is "up" in the opposite place') to the form of paradox which appears in the *Theaetetus* and in the *De sensibus*, whereby the *same* thing appears *differently*, we add to Plato's text a unified conception of movement, or at least of direction: centrifugal movement will be 'up' for earth measured at the centre, and 'down' for fire measured at the circumference. The 'unity' in this paradox, centrifugal movement, movement from centre to circumference, does not appear in Plato's text, and would not in fact be 'realised' (to use an Aristotelean conception) unless there were a body which moved from centre to circumference, which is nowhere said to be the case in Plato's statement of his theory.

It is true, it might perhaps be claimed that a 'unified' conception of movement or direction is implied by Plato's description of his 'geometrical' universe (62C8ff.), and in particular by his definition of centre and circumference. For the 'equal measures', by which the centre is separated from the circumference (cf. τὰ αὐτὰ μέτρα, 62D3), are in effect the radii of Plato's geometrical universe, and will therefore designate the pathway by which earth moves away from the centre, and by which fire moves towards the circumference (or *vice versa*).

But the same claim cannot be made for any corresponding 'unity' which would underlie the opposition of heavy and light, and which could be used to provide, for 'heavy' and 'light', the paradox whereby the same thing receives opposite designations from different observers, or from the same observer at different times.

For if we do imagine earth, for example, which is moved with difficulty away from the centre, as continuing its trajectory until it can be seen as moving towards the circumference, then the only conclusion that with any showing of plausibility can be said to be implicit in Plato's reasoning will again be that the larger quantity is still to be reckoned as 'heavy', since it will require a greater exertion on our part to force the larger

quantity to continue the journey away from its parent body, or to prevent the larger quantity returning to the centre, and to its parent body.

This problem can be avoided in the paradox for direction, since there we no longer employ the same element, earth or fire, as the 'unity' which will underlie the paradox: we employ the direction of movement, in abstraction from the nature of the body which we imagine as executing the movement. But for the paradox of weight there is no further unity which can be invoked, equivalent to the 'unity' of direction or movement. There is, in Plato's system, no trace of any common measure, by which weight can be calculated independently of the nature of the body which is weighed, and in such a way that this 'common measure' could then be interpreted differently for earth at the centre and for earth at the circumference. Indeed that condition is not properly fulfilled, even for the opposition of direction. Centrifugal movement is 'up' for earth and 'down' for fire; it is not (according to the terms of Plato's final definition) properly described as 'up' and 'down' for the same element. We therefore think to repair this inadequacy by describing the centrifugal movement itself as 'up' and 'down'; but there is no equivalent conception which can be at all easily or obviously introduced to act as the unity underlying the opposition of heavy and light.

I conclude that the two forms of paradox, that in the *Theaetetus* ('the same thing appears differently ...') and that in the *Timaeus* ('different things are called the same ...'), are convertible for the analysis of sweet and sour. They are also convertible for the analysis of direction, provided that we conceive of direction in abstraction from the moving body. On the interpretation that I have given of Plato's theory, they are not convertible for the analysis of heavy and light.

(vi)

The discrepancy between the two forms of paradox helps us to see more clearly the ambiguity in the relation between weight and direction in Plato's analysis in the *Timaeus*, which I alluded to earlier (pp. 51ff. above).

The initial impression of the *Timaeus* is that the analysis of weight is presented as wholly comparable to the analysis of direction. And if we take strict account of the requirement of Plato's final definition this is indeed so, in so far as for both weight and direction it is *true* that 'opposite' things appear the 'same' to different observers, and *not* true that the 'same' thing appears 'differently' to different observers. But this comparability of weight and direction depends upon the terminology for movement being determined by the nature of the moving body: if direc-

tion is conceived in abstraction from the nature of the moving body, then the paradox for direction may be converted to the form of paradox that appears in the *Theaetetus* and in the *De sensibus* (centrifugal movement would be in turn 'up' <for earth> and 'down' <for fire>), and once this has been done the two analyses, of weight and of direction, are no longer strictly comparable.

From this point of view, Taylor's interpretation has arisen from too close an identification of direction and weight (*cf.* esp. ch. III § 2, pp. 51-6 above). The two analyses of weight and of direction are comparable, only if we adopt the definition of direction contained in Plato's final definition. This Taylor does not do. Taylor interprets the paradox of direction independently of Plato's final definition, in the form therefore which is convertible to the form of paradox used for sweet and sour in the *Theaetetus* and in the *De sensibus*. Taylor then attaches to *this* form of the paradox the example of weight, and so constructs, for weight as for direction, the form of paradox whereby the *same* thing appears *differently* to the same observer at different times, or to different observers at the same time, with the result that the larger quantity of fire is *heavier* at the circumference, and *lighter* at the centre.

By contrast, according to Plato's own theory, or so I have argued, *either* we do not measure fire at the centre at all, *or* (if we adopt the extended sense of the final definition) fire which is measured as moving towards the earth *continues* to be reckoned as moving 'upwards' (since it is moving away from its parent body, *cf.* 63E3-7) and as 'lighter' in the smaller quantity (since less expenditure of effort would be required to *prevent* the smaller quantity *returning* to its parent body). In *either* case, it follows that the paradox for weight does not exist in the same 'double' form which can legitimately be constructed for the paradox of sweet and sour, or in an *abstracted* form for the paradox of up and down: (1) in these two cases, it is true *both* that 'opposite' things appear the 'same' to different observers, *and* that the 'same' thing appears 'differently' to different observers; (2) but in the case of heavy and light we know *only* that 'opposite' things (a large quantity of fire, a large quantity of earth) appear the 'same' ('heavier') to different observers, and *not* that the 'same' thing appears 'differently' to different observers.

Thus what may, at first blush, appear an insignificant discrepancy between the form of paradox which appears in the *De sensibus* or the *Theaetetus* and that which appears in the 'alignment of opposites' in the *Timaeus* proves, on reflection, to be essential to the whole cast of Plato's theory.

And yet does the discrepancy perhaps not have more to tell us? I have argued at length that Taylor's interpretation falsifies Plato's text. I shall

be misunderstood by the hasty and careless reader if I now remark that from one point of view Taylor has possibly understood Plato all too well. For I suspect that the paradox which Plato offers in the *Timaeus*, in what I have called 'the alignment of opposites' (63D6-E3), and even possibly the paradox contained in the account of the 'cosmic traveller' (63A2-4), are perhaps in part intended to call to mind the kind of argument that had elsewhere been associated with the relativity of the objects of sense, so as to prepare the reader for the shock (or more neutrally, for the innovation) that heavy and light, which earlier had not been reckoned among the *sensibilia* that were treated as 'affections of sense', should now be included among them.

To resume briefly: different forms of paradox, allied to the relativity of the objects of sense, are found in the *Theaetetus* and the *De sensibus*, and in the *Timaeus*. (1) In the *Theaetetus* and in the *De sensibus*, the same thing receives opposite appellations. (2) In the *Timaeus*, Plato writes only that *different*, or 'opposite', things are called the *same*. The *first* paradox, at least for sweet and sour, can be converted to the *second*. But the *second* paradox can be converted to the *first* only for direction, and only if direction is construed independently of the nature of the moving body. The *second* paradox cannot be converted to the *first*, for direction, if direction is determined by the nature of the moving body, as Plato requires it should be in his final definition; nor can the *second* paradox be converted to the *first* for weight, without falsifying Plato's conception of weight as defined by quantity and as measured by resistance. Consequently, in the *Timaeus*, Plato has to forego the logical (or linguistic) paradox that is associated elsewhere with the dependence of the *sensibilia* upon the conjunction of perceived object and percipient; and yet it would seem not unreasonable to suppose that it is precisely the appearance of similarity between the two forms of paradox, their apparent convertibility, which has perhaps helped to give the impression—to the reader, and possibly to Plato himself—that heavy and light can properly be explained as 'affections of sense', as had already been the case, in the atomic theory, and as is the case in Plato's own theory in the *Theaetetus*, for differences of temperature and for differences of taste.

(vii)

So far, I have taken account only of the paradox which is common to the *Theaetetus* and the *De sensibus*, namely the comparison of flavours. A different example of the paradox of relativity is provided earlier in the *Theaetetus* by the examples of number and size. (1) Six dice are at once more than four and less than twelve (154B-C). (2) Socrates is taller than

Theaetetus now, but he will be shorter than Theaetetus next year (155B-C).

At first sight, it is difficult to see quite how these two puzzles of size and number are intended to relate to the theory of sensation which Plato puts forward in the *Theaetetus* as the product of agent and patient, or of perceived object and percipient. From our point of view, the puzzle about large and small, or many and few, is a puzzle about relative terms, and not, or at least not directly, a puzzle about the relativity of sense perception. Six is more than four and less than twelve; from this, it is true, we may come to recognise that 'more' and 'less' have meaning only as relative terms; but from this it does not follow, or at least not very obviously, that 'more' and 'less' arise only from the conjunction of perceived object and percipient, in the way that 'hot' and 'cold' or 'sweet' and 'sour' may be said to do. The purpose of Plato's introduction of the example of relative quantity, or of relative size, in the *Theaetetus*, would seem therefore to be propaedeutic: 'more' and 'less', and 'large' and 'small', provide an extreme case where words which behave as though they represented intrinsic properties or powers prove, on reflection, to be dependent upon some human act of judgement or cognition.

The puzzle about relative size which appears in the *Theaetetus* Plato had already explored in the *Phaedo*, but in a context which was not designed to explain the dependence of the *sensibilia* upon the conjunction of perceived object and percipient. (1) In the *Theaetetus*, Plato's puzzle is that Socrates is taller than Theaetetus now but that he will be shorter than Theaetetus next year (155B-C). (2) In the *Phaedo*, Plato's puzzle is that Simmias is larger than Socrates, but at the same time smaller than Phaedo (102B-E). But the consequence which Plato draws from the two puzzles is different in either case. (1) In the *Theaetetus*, as I have noted, the puzzle about relative size appears to be used to prepare the reader to admit that use of the terms 'large' and 'small' has in some way to depend upon the co-operation of a percipient, and so to prepare him for the conclusion that non-relative terms, hot and cold, sweet and sour, are < also > dependent upon the conjunction of perceived object and percipient. (2) In the *Phaedo*, by contrast, the lesson Plato draws is that Simmias cannot himself be 'born by nature' to be large, but that there does exist another entity, 'largeness itself', which (to adopt the vocabulary that later in the argument Plato uses of the forms of numbers) is 'born by nature' to be large (102D-E, cf. 104A-B).

From this point of view, the peculiarity of the *Timaeus* is that we have the form of argument in the *Phaedo* with the conclusion of the *Theaetetus*. Plato's purpose in the *Timaeus* is to show that heavy and light, like other *sensibilia*, are dependent upon the conjunction of perceived object and

percipient, essentially therefore the theory of the *Theaetetus*. And yet the conclusion of the *Phaedo* that 'largeness itself' is 'born by nature' to be large is reflected in the form of Plato's analysis in the *Timaeus* of the cosmos as a perfect sphere: the world is 'born by nature' to be spherical; the parts of the circumference are all 'equally and in the same sense constituted by nature as extreme'; there is even, fleetingly, the appearance of the centre as 'itself in the centre' (αὐτὸ ἐν μέσῳ, *Tim.* 62C8-63A6; see further pp. 23ff. above for this comparison between the *Timaeus* and the form of argument in the *Phaedo*).

The importance of this borrowing from the *Phaedo* will be apparent if we return to reflect upon the nature of the 'unity' and the 'opposition' which underlie the two forms of paradox in the *Theaetetus* and in the *Timaeus*.

In the *Theaetetus*, the 'unity' which is not itself hot or cold, sweet or sour, but which will appear so to different observers at the same time, or to the same observer at different times, is some common object of experience: wind (152B) or wine (159B-E). If we convert the paradox of the *Theaetetus* to the form of paradox in the *Timaeus*, so that different, or opposite things appear the same, we have to look, not for an underlying unity, but for an underlying 'opposition'. Thus from the example of wine which is sweet for someone well and sour for someone ill (the paradox of the *Theaetetus*), we seek to construct the paradox whereby the same name, 'sour', may be attached to 'opposite' substances, wine and vinegar (the form of paradox in the *Timaeus*). In this case wine and vinegar appear as different, or as 'opposite', because wine is usually sweet, while vinegar is usually or always sour, so that, from this common or everyday point of view, wine may continue to be counted as opposite to vinegar, even when exceptionally (when the person who drinks the wine is ill) wine is given the same name 'sour' as vinegar.

In the *Timaeus*, I have argued that there is no 'unity' which could underlie the opposition of heavy and light, in such a way as to make the same thing appear both heavy and light to different observers at the same time, or to the same observer at different times. In the *Timaeus*, therefore, Plato presents only the form of paradox whereby different or 'opposite' things appear the same. But even for this form of paradox, the 'opposition' is not at once easy to identify. Thus wine and vinegar are usually opposed as sweet and sour, but exceptionally wine will also be called sour. Similarly, we may think to argue that the direction which is more usually 'down', since we are accustomed to life on earth, is movement towards the centre: movement from circumference to centre therefore remains opposed to movement from centre to circumference, even when exceptionally, i.e. for the observer at the circumference, movement from

the circumference to the centre is called movement 'upwards'. But if we do attempt to retain this conventional notion, of movement towards the centre as movement 'downwards', then we come dangerously close to undercutting Plato's initial condemnation of the naïve view, whereby "up" and "down" divide the whole between them' (*Tim.* 62C5-8): for Plato's critique of the naïve and conventional view has been designed to establish precisely that there is no privileged position in the universe which is 'up' or 'down': both terms are entirely relative, to the position of the observer or, in the final definition, to the movement of either element.

How then does Plato intend the body which is heavy at the circumference to be 'opposed' to the body which is heavy at the centre? By what criterion is movement which is 'up' at the circumference 'opposed' to movement which is 'up' at the centre?

Fairly plainly Plato's intention in the *Timaeus* is that the 'opposition' in his paradox should rest on the *refutation* that he has given of the popular and naïve view (62C5-8). Plato's own definition of centre and circumference establishes that the circumference is equidistant at every point from the centre, and that the centre is equidistant from the circumference and must therefore be reckoned as 'set against' or 'opposite to' all the points on the circumference equally (*καταντικρύ*, 62D4). This is Plato's answer to the naïve view that 'opposite places' divide the whole between them (*τόπους ... ἐναντίους*, 62C5-6). Plato corrects the notion that the two places should be called 'up' or 'down' exclusively, and he also rejects the distinction whereby, in this conventional sense, bodies which move 'upwards' (i.e. towards the circumference) do so only 'involuntarily'. But Plato's own definition is evidently *not* meant to challenge the notion that centre and circumference are 'opposites'. For the notion that the main masses of earth and fire occupy each a 'place opposite' to the other recurs in Plato's own analysis (*τόπον ἐναντίον*, 63D6). Thus in the formula that what is 'up' in one place is the opposite of what is 'up' in the opposite place the two entities, or directions, are clearly intended to correspond to movement inwards from the circumference and to movement outwards from the centre. The point of the paradox is that, in virtue of Plato's having established centre and circumference as positions which are 'by nature' opposed, movements towards, or away from, these positions *remain* opposed, even when they are characterised by the same term ('up' or 'down') by different observers, or in relation to different elements. Hence the paradox: movement away from the circumference and movement away from the centre are 'opposite'; nonetheless these 'opposite' movements are given the same name ('up') by an observer at the centre and by an observer at the circumference. Furthermore, it is

fairly plain that this same conception is intended to provide the opposition between heavy and light. When Plato writes that 'what is "light" in one place is the opposite of what is "light" in the opposite place' (63D6-E3), the opposition is not an opposition of quantity: for it is the smaller quantity of either element which is 'light'; and the larger quantity of either element which is 'heavy'. Equally, the opposition is not easily construed as an opposition in the nature of the elements: nothing in the context encourages us to see fire and earth as somehow intrinsically opposed. Fairly plainly, the opposition is again an opposition of place: the larger quantity of fire is more difficult to move away from the circumference, the larger quantity of earth is more difficult to move away from the centre.

Hence the importance for Plato of the analysis of the *Phaedo*. In order to construct the paradox of the *Timaeus* in a form which will not be convertible to the form of paradox in the *Theaetetus* and in the *De sensibus* Plato has to establish the 'opposition' in the paradox of the *Timaeus* on a basis *other* than the differentiation by which the two terms of the paradox are called the 'same'. Thus wine and vinegar may be counted as the 'same' or as 'opposite' (depending on the condition of the percipient); in either case the differentiation employed is the differentiation of sweet and sour; but Plato cannot allow that a large quantity of fire at the circumference and a large quantity of earth at the centre are both the 'same' and 'opposite' in virtue of being variously 'up' and 'down' or 'heavy' and 'light', for this would leave the paradox of the *Timaeus* open to conversion to the form of paradox in the *Theaetetus* and in the *De sensibus*, whereby the *same* thing would receive opposite appellations, with the unwanted consequence for his theory that the larger of two quantities of earth would be both heavy and light. Therefore in order to explain the feature of 'opposition' in his paradox Plato has recourse to an explanation of relative size, earlier in time and different in kind: in the *Timaeus* Plato tacitly invokes the theory of forms from the *Phaedo*, no longer, it is true, in their function of paradigms which have the same name as their instantiations, but in virtue of their freedom from the paradoxical relativity attaching to the objects of sense. Thus centre and circumference are introduced, in the *Timaeus*, as existing, and as opposed, 'by nature': as *exempted* therefore from the paradoxical inconsistency attaching to our use of the words 'up' and 'down' or 'heavy' and 'light'; and yet as *related* to those words sufficiently to provide the 'opposition' underlying the paradox that what is heavy, light, up or down in the one place is the 'opposite' of what is heavy, light, up or down in the opposite place.

(viii)

I have laboured this account of the difference between the two forms of paradox, in the *Timaeus* and in the *Theaetetus*, only partly in order to clarify the theory of the *Timaeus* and to fend off the loose and easy conflation of the two forms of paradox which leads to Taylor's interpretation. Once we have explored the difference between the two forms of paradox in the *Theaetetus* and in the *Timaeus*, and once we have appreciated the importance for the paradox of the *Timaeus* of the form of argument which Plato employs in the *Phaedo*, one final insight is open to us: the origins of the theory of weight which Aristotle will construct in the fourth book of the *De caelo*.

In the *Timaeus*, Plato's condemnation of the popular and naïve view prevents us from arguing that there is some residual sense of 'up' and 'down', whereby movement inwards from the circumference and movement outwards from the centre remain opposed, even when, by different observers, they are called by the same name 'up'. The opposition in the paradox of the *Timaeus* is therefore provided, not by some residual sense of 'up' and 'down', but by a form of argument reminiscent of the *Phaedo*: the conclusion of the *Phaedo* whereby 'largeness itself' is 'born by nature' to be large is reflected in the form of Plato's argument in the *Timaeus*, designed to portray the cosmos as 'by nature' a perfect sphere, where centre and circumference are 'by nature' opposed, but are not 'by nature' up or down.

The idea that sensible 'qualities', sweet and sour or hot and cold, exist 'by nature', or possess a 'nature', is of course precisely the idea that according to Theophrastus is denied by Democritus (*De sens.* 63; cf. Democritus fr. 9 DK = Sextus, *Adv. math.* vii 135), whose theory I have suggested Plato means to adapt for his analysis of weight. From this point of view, the paradox of relativity serves a quite different purpose in the *Phaedo* from the purpose it serves in the *Timaeus*. In the *Phaedo* Plato's purpose is precisely to establish that the character of 'large' or 'small' which adheres to Phaedo or Simmias in a relational, and therefore seemingly contradictory, sense attaches in a non-relational, and therefore (for Plato) non-contradictory, sense to the form which gives to Phaedo or Simmias the name of large or small. In the *Timaeus*, by contrast, Plato does not conclude that 'up' and 'down' or 'heavy' and 'light' exist in any formal or absolute sense. What exists 'by itself' or 'by nature' is not any direct verbal counterpart to our notion of weight or direction, but the world conceived as itself a geometrical solid where centre and circumference exist, and are opposed, 'by nature', precisely because they are liberated from the relativity, and the contradiction, attaching (for Plato) to our descriptions of direction.

It is however just this discrepancy between the conclusion of the *Timaeus* and the conclusion of the *Phaedo* which allows the borrowing from the *Phaedo* to solve the problem of the *Timaeus*. (1) From one point of view centre and circumference provide the objective correlate, the stable background, to the inconsistency, or at least the paradox, inherent (for Plato) in our descriptions of the world of sense. (2) On the other hand, although centre and circumference approximate, in their *status*, to the stability of the world of forms as described in the *Phaedo*, they do not approximate to them in their *nature*; from this point of view, centre and circumference exhibit the neutrality required for the objective correlate in Plato's account, in the *Timaeus* as in the *Theaetetus*, of how the *sensibilia* arise from the conjunction of perceived object and percipient. Thus the round atom, in Democritus' physics, or the tetrahedron, in the theory of the *Timaeus*, is not itself hot: it appears hot, or rather gives rise to the sensation of heat, only in conjunction with a sensible percipient. In the same way, centre and circumference are not themselves 'up' or 'down': they are given those names only when they are used as terms of reference by an observer, real or imaginary.

This is the moment in Plato's theory which perhaps most clearly points to the origin of Aristotle's conception of weight, and more particularly to Aristotle's distinction between absolute and relative weight. For Aristotle supposes that circumference and centre do exist as respectively 'up' and 'down' by nature, and equally that fire and earth are respectively 'light' and 'heavy' absolutely, i.e. independently of any difference of quantity. Thus in the same way that in the *Phaedo* 'largeness itself' can never tolerate smallness, i.e. can never be large *and* small (in the way that Socrates or Simmias can be, cf. *Phaedo* 102B-103A), so too for Aristotle, fire is always and only light, and earth is always and only heavy. A difference of quantity will make fire only more light or less light, but never in any sense heavy or heavier; while earth, conversely, in different quantities, may be only more heavy or less heavy, but never in any positive sense light or lighter. (The reader who finds this obscure will have to wait for the analysis of Aristotle's theory in my third volume.)

Thus the opposition in Aristotle's theory between fire which is exclusively and essentially light and earth which is exclusively and essentially heavy reflects, I would suggest, the opposition between centre and circumference in the *Timaeus*, which is in turn adapted, or so I have suggested, from the opposite forms of the *Phaedo*.

It is true, Aristotle sees the notion of absolute weight, and in particular the notion of fire as light absolutely, as his own innovation, the point at which his own theory most obviously diverges from common parlance, and from the theories of his predecessors, including Plato (see, for exam-

ple, *De caelo* iv 4, 311b16-19). And yet to the eye of the historian it is precisely at this point that the influence of Plato is, I think, unmistakable. For historically it is, I believe, reasonably clear that the notion of heavy and light as 'absolute' qualities has been in part derived, *via* the paradox of relativity in the *Timaeus*, from the theory of forms in the *Phaedo*. At least on this point Aristotle's 'science' is recognisably the heir of Plato's metaphysics.

BIBLIOGRAPHY

I have made no attempt to produce a complete bibliography of works relating to the *Timaeus*. The following list contains therefore (1) all works that for any reason have been cited in the text or footnotes, and (2) a few other works that may seem relevant, but which I have not had occasion to refer to.

Entries are arranged alphabetically under authors' names. Where relevant, references are given at the end of an entry to the pages of the present work on which the items in question have been cited.

I have added brief critical notes where I thought this might be useful; in some cases these notes are intended to explain why the item in question has not been dealt with more fully in the text.

APELT Otto. *Platons Dialoge 'Timaios' und 'Kritias', übersetzt und erläutert von O.A.*, in the series *Die philosophische Bibliothek* Band 179. Verlag von Felix Meiner, Leipzig. 1st edn 1919. 'Zweite durchgesehene Auflage', 1922. Pp. 224.

322. 324.

ARCHER-HIND Richard Dacre. *The 'Timaeus' of Plato, edited with introduction and notes*. Mac-Millan and Co., London and New York. 1888. Pp. vii + 358.

Archer-Hind (pp. 228-9) makes a brief attempt to relate the analysis of weight in terms of resistance to Plato's account of the winnowing movement in the receptacle, but not to Plato's account of the number of triangles. Not surprisingly therefore he finds that 'Aristotle in his criticism of Plato's theory ... simply ignores the whole point of it from beginning to end', while 'Aristotle's own doctrine', he tells us, 'differed but little from the vulgar notion on the subject'.

18-19. 82 n. 7. 99 n. 34. 137 n. 30. 138 n. 31. 142 n. 38. 182 n. 13. 210 n. 18. 322. 327ff. 369-70. 391. See also Beare, Cook Wilson, Shorey and Zannoni in the Bibliography.

ASHLEY Benedict M., O.P. 'Aristotle's sluggish earth', Part I 'Problematics of the *De caelo*', Part II 'Media of demonstration', *The new scholasticism* 32 (1958) 1-31 and 202-34. This was also published separately as *Aristotle's sluggish earth: the problematics of the 'De caelo'*, in the series *The Aquinas library*. Albertus Magnus Lyceum, River Forest, Illinois. 1958. Pp. 73.

285 n. 7.

AST Friedrich. *Platonis quae supersunt opera, accedunt Platonis quae feruntur scripta, ad optimorum librorum fidem recensuit in linguam latinam convertit annotationibus explanavit indicesque rerum ac verborum accuratissimos adiecit F.A.* Lipsiae, in libraria Weidmannia. 11 tomi, 1819-32. The *Timaeus*, tomus v (1822) 109-278.

319ff.

BAENSCH Otto. 'Die Schilderung der Unterwelt in Platons *Phaidon*', *Archiv für Geschichte der Philosophie* Band 16 n.F. 9 (1903) 189-203.

387ff.

BARNES Jonathan. *The Presocratic philosophers*, in the series *The arguments of the philosophers* ed. Ted Honderich. Routledge and Kegan Paul, London, Henley and Boston. 2 vols, 1979. Vol. i *Thales to Zeno*. Vol. ii *Empedocles to Democritus*. Vol. i, pp. xiv + 378. Vol. ii, pp. x + 353.

299 n. 35.

BAUERREIS Heinrich. *Zur Geschichte des spezifischen Gewichtes im Altertum und Mittelalter*. Inaugural-Dissertation ... der Friedrich-Alexanders-Universität Erlangen. Junge & Sohn, Erlangen. 1914. Pp. 127.

The account given of Plato and Aristotle (pp. 1-6) is wildly inaccurate. Bauerreis solemnly attributes to Plato exactly Aristotle's theory, p. 2: 'Spricht man von Schwersein, wenn der Körper die Richtung nach dem Erdmittelpunkt, von Leichtsein, wenn er die Richtung nach den Grenzen des Weltalls einschlägt.' The account given of Plato's comparison between copper and gold is equally imaginative, p. 5: 'Ist aber ein Körper härter und doch leichter als ein anderer, so lieft die Ursache in der Porosität. Die in den Zwischenräumen befindliche Luft bewirkt einen Trieb nach oben, also eine Abnahme der Schwere. Als Beispiel nennt er Gold und Erz.' Where is there even a breath of all this in Plato's text (*Tim.* 59A8-C3)?

BEARE John Isaac. *Greek theories of elementary cognition from Alcmaeon to Aristotle*. Clarendon Press, Oxford. 1906. Pp. vii + 354.

The section on heavy and light (pp. 186-7) is nothing more than an adaptation of Archer-Hind's translation of *Timaeus* 62C3-64A1.

BEKKER Immanuel. *Platonis dialogi, graece et latine*. Berolini, impensis Ge. Reimeri. 3 partes (pars i in 2 vols, and partes ii and iii each with 3 vols), 1816-18. The *Timaeus*, iii 2 (1817) 1-142.

319ff.

BEKKER Immanuel. *Platonis et quae vel Platonis esse feruntur vel Platonica solent comitari scripta graece omnia ... annotationibus integris Stephani, Heindorfii ... adiungiuntur modo non integrae Serrani, Cornarii ... necnon ex commentariis aliorum curiose excerpta*. Londini, excudebat A. J. Valpy, sumptibus Ricardi Priestley. 11 vols, 1826. The Greek text of the *Timaeus* is in vol. vii, pp. 231-373. Vols x-xi *Platonis dialogi latine juxta interpretationem Ficini aliorumque*. The *Timaeus*, vol. xi, pp. 237-76.

Cf. 319ff.

BLUCK Richard Stanley Harold. *Plato's 'Phaedo', a translation of Plato's 'Phaedo' with introduction, notes and appendices by R. S. B.* Routledge & Kegan Paul, London. 1955. Pp. x + 208. 387.

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89 n. 23.

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288 n. 16.

BRISSEON LUC. *Le même et l'autre dans la structure ontologique du 'Timée' de Platon, un commentaire systématique du 'Timée' de Platon*, in the series *Publications de l'Université de Paris X Nanterre, Lettres et sciences humaines, série A, Thèses et travaux* n° 23. Editions Klincksieck, Paris. 1974. Pp. 589.

In a succinct half-page (p. 443), Brisson avoids the pitfalls of Taylor's interpretation, but adds fresh errors of his own. Thus Brisson associates 'lourd' with movement 'vers le dissemblable', and 'léger' with movement 'vers le semblable', whereas Plato (esp. 63E3-7) says exactly the opposite. The discrepancy perhaps helps to explain why Brisson thinks that Plato's theory is 'très abstraite' and 'sort du champ du vécu', with the result that Aristotle 'fera intervenir alors la théorie des lieux naturels beaucoup plus près du sens commun et du vécu immédiat'.

The allusion to Aristotle is especially interesting, since Brisson also apparently maintains that the number of particles determines, not whether a body is heavy or light, but whether it is more heavy or less so, more light or less so. This seems to be plain both from his diagram, and from the claim: 'Cette chose est alors lourde ou légère, selon qu'elle va vers le dissemblable ou qu'elle revient vers le semblable. Elle est plus ou moins lourde ou légère, selon que la quantité de particules qui la composent est plus ou moins grande.' This gives us something not unlike the theory of Aristotle, where the direction of natural movement determines whether a body is heavy or light, while the larger or smaller quantity, by travelling with a difference of speed, determines whether a body is more heavy or less so, more light or less so. This is not at all the conception advanced in the *Timaeus* (62C3ff.), where the difference of quantity is directly attached to a difference in direction of movement and to a difference of heavy and light. Brisson's half-page is a neat illustration of how very few adjustments need to be made to the text of the *Timaeus* to yield a theory wholly alien to Plato's intention, and of how an interpretation quite other than that of Martin and Taylor nonetheless still shows the overwhelming influence of Aristotle on our reading of pre-Aristotelean philosophical texts.
152 n. 14. See also Mohr in the Bibliography.

BRUINS E. M. 'La chimie du *Timée*', *Revue de métaphysique et de morale* 56 (1951) 269-82.
80 n. 5. 360.

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9.

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CALDER William M., III (= William M. Calder the third). 'The spherical earth in Plato's *Phaedo*', *Phronesis* 3 (1958) 121-5.
388.

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3. 79. 82 n. 7. 105-6. 153ff., esp. 157. 158-9. 165 n. 40. 175-82. 208 n. 17. 283. 284. 287 n. 15. 304ff. 328. 331-5. 359-65. See also Mohr in the Bibliography.

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The main purpose of this work is to establish a general identity of opinion between Plato and Aristotle. This is attained in part by adopting a highly generalised version of the theories of the *Timaeus* and of Aristotle, in part by offering an Aristoteleanised version of Plato, as that for Plato 'qualities were potentially in the substrate' (p. 59), and in part by the apparent assumption that even when Aristotle reproduces and criticises the theories of the *Timaeus* he is in fact concerned to attack thinkers other than Plato.

The account of weight (pp. 50-9), which is included in an analysis of qualities more generally, appears to follow this general direction: for example, we are told of Plato that 'both he and Aristotle held the same views regarding the cause of weight'

(p. 58). It is therefore rather puzzling to be told later that 'the cause of weight' is an occasion when, exceptionally, the theories of Plato and of Aristotle are 'beyond reconciliation' (p. 98).

Matters are not helped by a blatant misunderstanding of the text at 63B2-C1, whereby the comparison between a larger and a smaller quantity of fire is initially taken to be a comparison between the whole body of fire and a single small portion which is detached from it (p. 52).

18. 330. 363-5.

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99 n. 34. 330. 369-70.

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124 n. 2. 135 n. 26. 144ff.

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11ff. 33 n. 3. 36 n. 7. 45. 84ff. 90ff. 97ff. 102-3. 106. 111 n. 7. 114. 117ff., esp. 122 n. 22. 124-8. 134-7. 138 n. 31. 141. 144ff. 165-6. 319ff., esp. 324. 330-1. 341ff., esp. 347ff. and 357ff. 359ff. 366ff. 369ff., esp. 375ff. 396ff., esp. 400. 416. See also Pohle and Popper in the Bibliography.

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DE VRIES, see VRIES.

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324. 395.

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246ff., esp. 252. See also Stratton in the Bibliography.

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A long but curiously neutered account of Plato's theory of sensation (pp. 197-228), including comparison with Presocratic and with modern ideas, quite fails to touch upon the connection that I have sought to establish between *gene* and *pathemata*. Thus in the account of heavy and light among the *pathemata* (pp. 198-9), no mention at all is made of the earlier definition, of weight by number.

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Plato, 'La pesanteur', tome i pp. 49-51. After assuming that Democritus' atoms fall in the void, Duhem announces, p. 49 n. 2, that 'dans le texte que nous avons consulté, les mots μικρόν et πολύ sont permutés par une erreur évidente' (63C4-5). Duhem then proceeds from the—for Plato—nonsensical assumption that what is large is light and that what is small is heavy.

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FRACCAROLI Giuseppe. *Platone, il 'Timeo', tradotto di G. F.*, in the series *Il pensiero greco* vol. i. Fratelli Bocca editori, Torino. 1906. Pp. xvi + 424.

This contains a translation, a long introduction and extensive notes. On the question of weight, Fraccaroli does offer guidance on one or two points of detail (pp. 295-300), but his attitude generally is that: 'La teoria dell'attrazione e della gravitazione è esposta qui', i.e. 62C-63E, 'così chiaramente (ancorchè Aristotele non l'abbia ben capita) che è superfluo qualsiasi commento' (p. 295 n. 2). Oh, the crassness and the sad, sad irony of it all.

137 n. 30. 319ff., esp. 323.

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182 n. 13. 200ff. 210 n. 18. 283.

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82 n. 8. 286 n. 11. 353.

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390. 391.

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89 n. 23. 344. 368.

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288 n. 6.

HAMMER JENSEN Ingeborg. 'Demokrit und Platon', *Archiv für Geschichte der Philosophie* 23 n.F. 16 (1910) 92-105 and 211-29.
289 n. 17.

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80 n. 5.

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There is nothing of interest here for the history of weight, other than the isolated remark quoted by Solmsen.

158 n. 24.

JOHNSON Harold J. 'Three ancient meanings of matter: Democritus, Plato, and Aristotle', *Journal of the history of ideas* 28 (1967) 3-16.

I include this item only lest the title should rouse false hopes: the treatment is hopelessly general.

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KRANZ Wilhelm, see DIELS Hermann, 1903/1934-7.

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This compares Plato with Newton and Aristotle with the 'new physics', i.e. Einstein. The parallels drawn are very loose.

KUSAYAMA Kyoko. 'A note on πάθημα, πάθος in Plato's cosmology', *Journal of classical studies* (Kyoto, Japan) 26 (1978) 53-67, with an English summary 153-4.

To judge from the summary, some interesting questions are asked, and left unanswered.

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322. 324.

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203 n. 13.

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203 n. 13. 322.

McDIARMID J. B. 'Plato in Theophrastus' *De sensibus*', *Phronesis* 4 (1959) 59-70.

182 n. 13. 218 n. 5. 247 n. 3. 334-5.

McDOWELL John Henry. *Plato 'Theaetetus', translated with notes*, in the *Clarendon Plato series*. Clarendon Press, Oxford. 1973. Pp. [iii] + 264.
144 n. 3.

MANNSPERGER Dietrich. *Physis bei Platon*. Walter de Gruyter & Co., Berlin. 1969. Pp. 336.
25 n. 33.

MARICKI Ksenija. 'Platon i Demokrit' [in Serbo-croat, with a summary in German, 'Zusammenfassung Platon und Demokrit'], *Filozofija, Jugoslovenski časopis za filozofiju* 7 (1963) 89-96.

I include this one article, as typical of several on the same subject. The treatment is not unintelligent, but it is highly generalised.

MARTIN Thomas Henri. *Études sur le 'Timée' de Platon*. Ladrangé librairie-éditeur, Paris. 2 tomes, 1841. Tome i, pp. xii + 428. Tome ii, pp. 462.
95 n. 29. 98ff. 124 n. 3. 179 n. 10. 304ff. 319ff. 327ff., esp. 331ff.
335. 361. 366ff. 373ff. 376ff. 417ff. See also Brisson in the Bibliography.

MARTINI Emidio. *Platone, 'Timeo', 'Critia', 'Minos', traduzione di E.M. G. B. Paravia*, Torino *et alibi*. 1935. Pp. 154.
322-3.

MAULA Erkka. *Studies in Plato's theory of forms in the 'Timaeus'*, in the series *Annales Academiae scientiarum Fennicae* ser. B tom. 169, i (Helsinki, 1970). Pp. 31.
152 n. 14.

MOHR Richard. 'The mechanism of flux in Plato's *Timaeus*', *Apeiron, a journal for ancient philosophy and science* (Monash University) 14 (1980) 96-114.

Some promising remarks on the distinction between 'two different senses of weight in the *Timaeus*' (p. 107) nonetheless peter out into futility. Thus Mohr tells us (n. 71 = p. 114) that 'if one carries a mass in the direction in which it naturally drifts (say, fire towards the rim of the universe), it *feels* light'. But alas, in the passage quoted ('63e', presumably 63E3-7, what I have called the 'final definition', see pp. 39-41 above), Plato tells us almost exactly the opposite: namely that the movement of a body towards its parent element, and therefore of fire towards the circumference, makes that body heavy, and not light. How has Mohr extrapolated from this text the sentence I have quoted? Mohr (like Brisson) is to be congratulated on escaping from the influence of Cherniss (see esp. his note 70 = p. 114); but Mohr's own interpretation (like Brisson's) is just as much at odds as that of Cherniss with what we can actually read for ourselves in the pages of the *Timaeus*.

MORAUX Paul. *Aristote 'Du ciel', texte établi et traduit par P.M.*, in the series *Collection des Universités de France*, publiée sous le patronage de l'Association Guillaume Budé. Société d'édition 'Les Belles Lettres', Paris. 1965. Pp. cxc + 165 (double pagination for Greek text and French translation).

Pp. cxlii-clvii, 'La pesanteur et la légèreté', contain an analysis of *De caelo* book four, and of the Platonic theory which Aristotle there criticises.
79 n. 3. 182 n. 13. 232 n. 10. 335. 355-6.

MOREAU Joseph. Translation into French of the *Timaeus* in Léon Robin, *Platon, œuvres complètes, traduction nouvelle et notes par L.R.*, in the series *Bibliothèque de la Pléiade* nos 58 and 64. Bibliothèque de la Pléiade, Paris. 2 vols, 1940-2. Vol. ii 'avec la collaboration de M. J. Moreau'. The *Timaeus*, by J.M., vol. ii (1942) 431-524 (translation), 1464-80 (notes).
323.

MORRISON J. S. 'Parmenides and Er', *Journal of hellenic studies* 75 (1955) 59-68.
388.

- MORRISON J. S. 'The shape of the earth in Plato's *Phaedo*', *Phronesis* 4 (1959) 101-19. 388ff., esp. 395.
- MORROW Glen R. 'Plato's theory of the primary bodies in the *Timaeus* and the later doctrine of forms', *Archiv für Geschichte der Philosophie* n.F. 50 (1968) 12-28. 152 n. 14. 287 n. 13.
- MORTLEY Raoul J. 'Primary particles and secondary qualities in Plato's *Timaeus*', *Apeiron, a journal for ancient philosophy and science* (Monash University) 2 (1967) 15-17. 152 n. 14.
- MORTON Joseph. *The development of Plato's theory of sense perception*. Doctoral dissertation, John Hopkins University. 1968. Pp. 168.
Of this work I regret that I have been able to see only the interesting summary that appears in *Dissertation abstracts* 29 (1968) 1570A.
- MUGLER Charles. *Platon et la recherche mathématique de son époque*. Editions P. H. Heitz, Strasbourg/Zurich. 1948. Pp. xxviii + 427. 345.
- MUGLER Charles. *La physique de Platon*, in the series *Etudes et commentaires* n° 35. Klincksieck, Paris. 1960. Pp. 263. 341ff.
- MÜLLER Hieronymus. *Platon's sämtliche Werke, übersetzt von H.M., mit Einleitungen begleitet von Karl Steinhart*. F. A. Brockhaus, Leipzig. 10 Bände, 1850-73. The *Timaeus*, Band vi (1857) 1-299. 322.
- NAKHNIKIAN George. 'Plato's theory of sensation', *Review of metaphysics* 9 (1955-6) 129-48 and 306-27.
This study does help with some points in the theory of the *Theaetetus*, but it is woefully inadequate as an account of sensation in the *Timaeus*, despite Nakhnikian's claim (p. 129) that 'the material in these two parts covers almost everything that Plato says about sensation in the dialogues' (an expression which is evidently meant to include the *Timaeus*). 145 n. 4.
- NESTLE Wilhelm, see ZELLER Eduard, 1844/1920.
- O'BRIEN D. 'Anaximander's measurements', *Classical quarterly* n.s. 17 (1967) 424-32. 23 n. 32.
- O'BRIEN D. 'The last argument of Plato's *Phaedo*', Part I *Classical quarterly* n.s. 17 (1967) 198-231, Part II n.s. 18 (1968) 95-106. 26 n. 35. 32 n. 2.
- O'BRIEN D. 'The relation of Anaxagoras and Empedocles', *Journal of hellenic studies* 88 (1968) 93-113. 160 n. 28.
- O'BRIEN D. 'Derived light and eclipses in the fifth century', *Journal of hellenic studies* 88 (1968) 114-27. 326.
- O'BRIEN Denis. *Empedocles' cosmic cycle, a reconstruction from the fragments and secondary sources*,

in the series *Cambridge classical studies*. University Press, Cambridge. 1969. Pp. x + 459.
88 n. 21. 146 n. 8. 201 n. 11.

O'BRIEN D. 'The effect of a simile: Empedocles' theories of seeing and breathing', *Journal of hellenic studies* 90 (1970) 140-79.
168 n. 44.

O'BRIEN D. 'Anaximander and Dr Dicks', *Journal of hellenic studies* 90 (1970) 198-9.
326.

O'BRIEN D. 'Heavy and light in Democritus and Aristotle: two conceptions of change and identity', *Journal of hellenic studies* 97 (1977) 64-74.

An introductory outline to some parts of the present work.

O'BRIEN Denis. 'A metaphor in Plato: "running away" and "staying behind" in the *Phaedo* and the *Timaeus*', *Classical quarterly* n.s. 27 (1977) 297-9.
26 n. 35.

O'BRIEN Denis. 'Aristote: quantité et contrariété, une critique de l'école d'Oxford', in *Concepts et catégories dans la pensée antique*, 'études publiées sous la direction de Pierre Aubenque', in the series *Bibliothèque d'histoire de la philosophie*. Vrin, Paris. 1980. Pp. 89-165.
299 n. 35.

O'BRIEN Denis. 'Temps et intemporalité chez Parménide', *Les études philosophiques: le Temps* (1980) 257-72.
299 n. 35.

O'BRIEN Denis. *Theories of weight in the ancient world. Four essays on Democritus, Plato and Aristotle. A study in the development of ideas*. 4 vols. Vol. i *Democritus: weight and size. An exercise in the reconstruction of early Greek philosophy*. In the two series *Collection d'études anciennes* and *Philosophia antiqua* vol. 37. Société d'édition 'Les Belles Lettres', Paris. E. J. Brill, Leiden. 1981. Pp. xxii + 419.

5-7. 7 n. 11. 85 n. 15. 88. 93 n. 27. 96. 164 n. 38. 182 n. 13. 194 n. 2.
196 n. 7. 199 n. 8. 201 n. 11. 208 n. 17. 210 n. 18. 223 n. 13. 225 n. 16.
234 n. 13. 244 n. 23. 282. 285-7. 287 n. 14. 288 n. 16. 298 n. 33. 311ff.,
esp. 316 n. 59 and n. 60. 341. 364.

O'BRIEN D. 'Préjugé et présupposé en histoire de la philosophie: la taille et la forme des atomes dans les systèmes de Démocrite et d'Epicure', *Revue philosophique de la France et de l'étranger* année 107 tome 172 (1982) 187-203.
341.

PHILIPPSON Ludwig. "Ἰλη ἀνθρωπίνη. Pars i: *De internarum humani corporis partium cognitione Aristotelis cum Platonis sententiis comparata*. Pars ii: *Philosophorum veterum usque ad Theophrastum doctrina de sensu* [with three subtitles of which the first is] *Theophrasti de sensu et sensilibus fragmentum historico-philosophicum, cum textu denuo recognito prima conversio latina et commentaria ... scripsit et edidit L.P. Berolini, sumtibus J. A. List*. 1831. Pp. vii + 252.

Introduction, text, translation and commentary for Theophrastus *De sensibus*, pp. 81-229.

233ff. 247 n. 3. 285 n. 8.

POHLE William Baldwin. *Studies in the physical theory of Plato's 'Timaeus'*. Doctoral dissertation, Princeton University. 1969. Pp. 172.

I regret that I have been able to see of this work only the summary that appears in *Dissertation abstracts* 30 (1969) 1204A.

POHLE William. 'The mathematical foundations of Plato's atomic physics', *Isis* 62 (1971) 36-46.

341.

POHLE William. 'Dimensional concepts and the interpretation of Plato's physics', in *Exegesis and argument, studies in Greek philosophy presented to Gregory Vlastos*, edd. E. N. Lee, A. P. D. Mourelatos, R. M. Rorty, in *Phronesis*, supplementary volume 1. Van Gorcum, Assen. 1973. Pp. 306-23.

Pohle here renews his criticism of Cornford (pp. 309ff.; cf. p. 341 above), and adds some interesting, but ultimately disjointed, remarks on the 'two' theories of weight in the *Timaeus*. For example, Pohle writes, by way of reconciling the two theories, that 'a fire particle (composed of at least 24 elementary triangles) is plausibly supposed to be lighter than an air particle (composed of at least 48 such triangles) since despite the fact that on earth both tend "upwards", the fire particle would suffer at the hands of the air particle a "downward", "anti-natural" movement in any situation in which the motion of either entails an equal but opposite displacement of the other' (p. 318). But what 'situation' can this be thought to be? We cannot, by weighing, compare air and fire in air, since the air we 'weigh' is then already joined to its parent element. Similarly, with fire. But how could we weigh air and fire inside water or inside earth? And yet, if Pohle does not describe 'weighing', then by what means has he extrapolated from Plato's text the formula which I have quoted? Pohle's all too abstract approach seems to have hindered him from considering such simple objections to his interpretation.

On the comparison between copper and gold (*Tim.* 59A8-C3; see pp. 89-96 above), Pohle concludes that in a theory such as Plato's 'there is simply no incompatibility between a mass's having been more compressed (and therefore being denser) and its having large gaps in its texture' (pp. 322-3). This seems hardly more than a re-statement, or even a denial, of the problem, rather than a solution of it.

POPPER Karl Raimund. *The open society and its enemies*. George Routledge & Sons, London. 2 vols, 1945. Vol. i *The spell of Plato*. Vol. ii *The high tide of prophecy: Hegel, Marx, and the after-math*. Vol. i, pp. vii + 268. Vol. ii, pp. v + 352.

— 2nd [American] edn 'revised'. Princeton University Press, Princeton, New Jersey. 1 vol., 1950. Pp. xii + 732.

— 2nd [English] edn 'revised'. Routledge & Kegan Paul, London. 2 vols, 1952. Vol. i, pp. vii + 318. Vol. ii, pp. v + 375.

— 3rd edn 'revised'. Routledge & Kegan Paul, London. 2 vols, 1957. Vol. i, pp. xi + 322. Vol. ii, pp. v + 391.

— 4th edn 'revised'. Routledge & Kegan Paul, London. 2 vols, 1962. Vol. i, pp. xi + 351. Vol. ii, pp. v + 420.

— 5th edn 'revised'. Routledge & Kegan Paul, London. 2 vols, 1966. Vol. i, pp. xi + 361. Vol. ii, pp. v + 420.

The attack on Cornford's hypothesis of equal subelemental triangles is not contained in the first edn of Popper's work (1945). It first appears, with the word 'triangles', in the edn published at Princeton in 1950, p. 528 (= ch. 6 note 9). The word 'triangles' is corrected to 'figures' in the London edn of 1952, vol. i p. 250. The correction is maintained in the 3rd edn, again vol. i p. 250, which includes a supplement to Popper's note (vol. i p. 319: 'Addendum: Plato and geometry'), and in the 4th and 5th edns (again vol. i p. 250, with an enlarged version of the 'addendum', pp. 319-20). I regret that I have not been able to see any of the later American editions given in the *National Union Catalog* as subsequent to the 1950 Princeton edn (listed as 1956, 1963 and 1966). See also the following entry.

341. 345-9.

POPPER K. R. 'The nature of philosophical problems and their roots in science', *The British journal for the philosophy of science* 3 (1952-3) 124-56.

Popper here repeats (esp. pp. 149-52) his interpretation of Plato's theory of triangles in the *Timaeus*, but without returning to his criticism of Cornford. One's confidence in Popper's mastery of the by-ways of ancient philosophy is not increased when he tells us, on the basis of a fragment of Democritus recorded by Sextus (DK 68B164), which hardly affirms more than a belief in the principle of 'like to like', and with only briefest mention of a *dinos*, that Plato took over unchanged Democritus' 'theory of what we nowadays would call gravitational phenomena', and that this same theory, 'slightly modified by Aristotle, was ultimately discarded by Galileo' (p. 147 n. 1).

I am perplexed by Popper's allusion, in this article, p. 134 n. 2, to a 'revised 4th edition' of *Open society and its enemies*, dated 1952. Has Popper perhaps counted a 2nd edition as a 4th by including the two reprintings of the 1st edition (in 1947 and in 1949) as 'editions'? See also the following entry.

POPPER Karl Raimund. *Conjectures and refutations, the growth of scientific knowledge*. Routledge & Kegan Paul, London. 1st edn 1963. 'Third edition (revised)', 1969. Pp. xiii + 431.

This is a collection of earlier essays, including, pp. 66-96: 'The nature of philosophical problems and their roots in science' (see the preceding entry). For triangles in the *Timaeus*, see esp. pp. 90-3. For Democritus and 'gravitational phenomena', see p. 88 n. 43. The 4th edn of *Open society and its enemies* is now happily dated to 1962 (p. 75 n. 15).

PRINS Jan (SCHEPP C. L.). *Platoon's 'Timaios', in het nederlandsch overgebracht en van inleiding en toelichting voorzien door J.P. (C.L.S.)* Lectura-Uitgaven, Antwerpen. Boucher's Uitgeverij, Den Haag. n.d. [1937?] Pp. 167.

322.

RITTER Constantin. *Platon, sein Leben, seine Schriften, seine Lehre*. C. H. Beck'sche Verlagsbuchhandlung, München. 2 Bände, 1910-23. Band i, pp. xv + 588. Band ii, pp. xv + 910.

330.

RITTER Constantin. *Die Kerngedanken der Platonischen Philosophie*. Verlag von Ernst Reinhardt, München. 1931. Pp. x + 346.

330.

RIVAUD Albert. 'Timée' — 'Critias', *texte établi et traduit par A.R.*, in the series *Collection des Universités de France*, publiée sous le patronage de l'Association Guillaume Budé. *Platon, œuvres complètes* tome x. Société d'édition 'Les Belles Lettres', Paris. 1925. 'Cinquième tirage revu et corrigé', 1970. Pp. 274 (double pagination for Greek text and French translation).

323. See also Shorey and Zannoni in the Bibliography.

ROBIN LÉON. *La théorie platonicienne des idées et des nombres d'après Aristote, étude historique et critique*. Félix Alcan éditeur, Paris. 1908. Pp. xvii + 702.

Pp. 252-6 consider Aristotle's criticism, that bodies with weight cannot be composed of surfaces, or of points, which have no weight (*De caelo* iii 1, 299a17ff.; cf. *De gen. et corr.* i 2, 315b28ff.): the whole is hardly more than a paraphrase.

ROBIN LÉON. 'Etudes sur la signification et le place de la physique dans la philosophie de Platon', *Revue philosophique de la France et de l'étranger* année 43 tome 86 (1918) 177-220 and 370-415. This was also published separately by La librairie Félix Alcan, Paris, 1919. It is reprinted in *La pensée hellénique* 231-336.

374.

ROBIN LÉON. *Platon*, in the series *Les grands philosophes*. 1st edn 1935. Félix Alcan, Paris.

Pp. viii + 364. 'Nouvelle édition avec bibliographie mise à jour et complétée', in the series *Les grands penseurs*, collection dirigée par P.-M. Schuhl. Presses Universitaires de France, Paris. 1968. Pp. viii + 272.
374.

ROBIN LÉON. *La pensée hellénique des origines à Épicure, questions de méthode, de critique et d'histoire*, in the series *Bibliothèque de philosophie contemporaine*. Presses Universitaires de France, Paris. 1942. Pp. 554. The pagination is unchanged in the 2nd edn, Presses Universitaires de France, Paris, 1967.

This is a collection of some of Robin's earlier articles, including, pp. 231-336, 'Études sur la signification et la place de la physique dans la philosophie de Platon' (1918).
374.

ROBINSON John. 'Anaximander and the problem of the earth's immobility', in *Essays in ancient Greek philosophy*, edd. John P. Anton, George L. Kustas. State University of New York Press, Albany, New York. 1971. Pp. 111-18.
325-6.

ROMMEL. 'Stahl', Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft* Reihe 2 Band 3 (1929) 2126-33.
89 n. 23.

ROSENMEYER Thomas G. 'Phaedo 111C4ff.', *Classical quarterly* n.s. 6 (1956) 193-7.
388ff.

ROSENMEYER Thomas G. 'The shape of the earth in the *Phaedo*: a rejoinder', *Phronesis* 4 (1959) 71-2.
388ff.

ROSS Sir [William] David. *Plato's theory of ideas*. Clarendon Press, Oxford. 1951 (several corrected reprints). Pp. vi + 252.
144 n. 2.

SACHS Eva. *Die fünf platonischen Körper, zur Geschichte der Mathematik und der Elementenlehre Platons und der Pythagoreer, von E.S.*, in the series *Philologische Untersuchungen* Heft 24. Weidmannsche Buchhandlung, Berlin. 1917. Pp. viii + 242.
287 n. 15. See also Schulz in the Bibliography.

SCHNEIDER Karl Ernst Christoph. *Platonis opera ... graece et latine*, by R. B. Hirschig, K.E.C.S., et alii. Parisiis, editore Ambrosio Firmin Didot. 3 vols, 1846-73. The *Timaeus*, by K.E.C.S., vol. ii (1846) 196-249.
322.

SCHULZ Dietrich Joachim. *Das Problem der Materie in Platons 'Timaios'*, in the series *Abhandlungen zur Philosophie, Psychologie und Pädagogik* Band 31. H. Bouvier und Co. Verlag, Bonn. 1966. Pp. 131.

Schulz rightly places his account of heavy and light within his treatment of 'Die Ableitung der Qualitäten' (pp. 31-9), but neither here nor in his further treatment, 'Die Ableitung der Phänomene ... Analyse charakteristischer Beispiele: Schwere und Undurchdringlichkeit' (pp. 113-22), is there any detailed analysis of the later passage in the *Timaeus*, while Schulz refers specifically to the earlier passage (56B1-2) only once (p. 115 n. 345), and even then only in refutation of Eva Sachs. The concluding pages (pp. 123-7), with a comparison of Plato and Democritus and an attempt to explain the transition in Plato's world from triangles to the apparently solid bodies of our experience, though interesting as they stand, suffer both from this lack

of precision, and from Schulz's repeatedly leaving an open question whether or not Democritus' atoms had weight (pp. 38 n. 135; 113; 123).
287 n. 13. 371.

SHOREY Paul. 'Recent Platonism in England', *American journal of philology* 9 (1888) 274-309.

This is an important criticism of the interpretations of Plato's ontology that had then recently been advanced by Archer-Hind and others: it is also intended as an introduction to Shorey's later articles on the *Timaeus*.

SHOREY Paul. 'The interpretation of the *Timaeus*', *American journal of philology* 9 (1888) 395-418.

SHOREY Paul. 'The *Timaeus* of Plato', *American journal of philology* 10 (1889) 45-78.
137 n. 30.

SHOREY P. 'Recent interpretations of the *Timaeus*', *Classical philology* 23 (1928) 343-62.
The interpretations are those of Rivaud, Taylor and Frank: there is a long series of exegetical notes on particular passages, repeated and in part corrected from Shorey's earlier articles.
137 n. 30.

SHOREY Paul. *What Plato said*. The University of Chicago Press, Chicago, Illinois. 1933.
Pp. vii + 686.
152 n. 14.

SKEMP J. B. 'Plants in Plato's *Timaeus*', *Classical quarterly* 41 (1947) 53-60.
140 n. 33.

SOLMSSEN Friedrich Rudolph Heinrich. *Aristotle's system of the physical world, a comparison with his predecessors*, in the series *Cornell studies in classical philology* vol. 33. Cornell University Press, Ithaca, New York. 1960. Pp. xiv + 468.

Ch. 13, pp. 275-86: 'Heavy and light'.
79. 82 n. 7. 105-6. 153ff., esp. 157. 158-9. 175ff. 214-15. 283. 284 n. 6. See also Jaeger in the Bibliography.

STALLBAUM Gottfried. *Platonis quae supersunt opera, textum ... recognovit G.S. Lipsiae, sumptibus J. A. G. Weigelii. Lugduni Batavorum, apud S. et J. Luchtmans. 12 tomi, 1821-5. The Timaeus, tomus vii (1824) 1-99.*

STALLBAUM Gottfried. *Platonis opera omnia, recensuit et commentariis instruxit G.S.*, in the series *Bibliotheca graeca ... Gothae et Erfordiae, sumptibus Guil. Hennings. 10 vols, 1833-59. The Timaeus, vol. vii (1838) 1-369. 319ff.*

STOCKS John Leofric. Translation of the *De caelo*, in *The works of Aristotle translated into English* ed. W. D. Ross. Clarendon Press, Oxford. Vol. ii, 1930. There is no separate pagination.
86 n. 16. 177 n. 7. 353-5.

STOUGH Charlotte L. 'Forms and explanation in the *Phaedo*', *Phronesis* 21 (1976) 1-30.
26 n. 35.

STRATTON George Malcolm. *Theophrastus and the Greek physiological psychology before Aristotle*. George Allen and Unwin, London. MacMillan and Company, New York. 1917. Pp. 227.

This contains Diels' text, with a translation, and notes in part transcribed from correspondence with A. E. Taylor.

212 n. 23. 216ff. 228ff., esp. 239-44. 245ff. 267ff. 304ff. 332ff.

TAYLOR Alfred Edward. *A commentary on Plato's 'Timaeus'*. Clarendon Press, Oxford. 1928. Pp. xv + 700.

9. 10ff. 45-50. 51ff. 62ff. 70ff. 95 n. 29. 99 n. 34. 106. 122 n. 22. 124ff. 128-34. 135. 136. 137. 137 n. 30. 138. 141. 142 n. 38. 155ff. 175ff. 208 n. 17. 216ff. 228ff. 245ff., esp. 250-1, 260. 267ff., esp. 273, 275. 285 n. 8. 304ff. 319ff., esp. 323, 324. 327-40. 359ff. 366-8. 369ff., esp. 377, 379. 396ff., esp. 400. 416. 417ff. See also Brisson, Shorey and Zannoni in the Bibliography.

TAYLOR Alfred Edward. *Plato: 'Timaeus' and 'Critias', translated into English with introduction and notes on the text by A.E.T.* Methuen, London. 1929. Pp. vii + 136.

10ff. 359. 361.

TAYLOR Alfred Edward, see also under STRATTON George Malcolm.

VLASTOS Gregory. 'Plato's supposed theory of irregular atomic figures', *Isis* 58 (1967) 204-9.

344.

VLASTOS Gregory. *Plato's universe*. Clarendon Press, Oxford. 1975. Pp. xiii + 130.

80 n. 5. 298 n. 34.

VRIES G. J. de. 'Note on Plato, *Rep.* 367C', *Mnemosyne* series 3a vol. 13 (1947) 202.

324.

WAGNER Friedrich Wilhelm. *Platons Werke, griechisch und deutsch, mit kritischen und erklärenden Anmerkungen*. Verlag von Wilhelm Engelmann, Leipzig. 26 Theile, 1841-81. The *Timaeus*, Theil xv (1853) i-xxviii (introduction), 1-185 (Greek text and German translation), 228-301 (notes).

The translations in this collection are by various hands, which are not clearly indicated in the volumes themselves; for Wagner's translation (or simply editorship?) of Theil xv, which includes the *Timaeus*, see *Allgemeine Deutsche Biographie* Band 14 (Leipzig, 1896) 495-6.

322.

WARRINGTON John. *Plato 'Timaeus', edited and translated with an introduction*, in the series *Everyman's library*. Dent, London. Dutton, New York. 1965. Pp. x + 138.

322.

WEISHEIPL James Athanasius, O.P. 'The concept of nature', 'Natural and compulsory movement', 'Space and gravitation', *The new scholasticism* 28 (1954) 377-408, 29 (1955) 50-81 and 175-223. These three articles are reprinted, with the addition of a short introduction and a bibliography, as *Nature and gravitation*, in the series *The Aquinas library*. Albertus Magnus Lyceum, River Forest, Illinois. 1955. Pp. viii + 124. This work notes a first chapter 'The problem of motion' as 'not printed'.

285 n. 7.

WHITEHEAD Alfred North. *An enquiry concerning the principles of natural knowledge*. University Press, Cambridge. 1st edn 1919. Pp. xiv + 200. 2nd edn 1925. Pp. xiv + 207. The pagination in the two editions is the same, with the exception of pp. 201-7 which contain 'Notes', peculiar to the 2nd edn.

106.

WHITEHEAD Alfred North. *The concept of nature*, with the subtitle *Turner lectures delivered in Trinity College, November 1919*. University Press, Cambridge. 1920. Pp. viii + 202.
106. 285 n. 8. 370. 398.

WICHMANN Ottomar. *Platon, ideelle Gesamtdarstellung und Studienwerk*. Wissenschaftliche Buchgesellschaft, Darmstadt. 1966. Pp. ix + 703.
330.

WILLIAMSON Harold. Πλατῶνος Φαῖδων. *The 'Phaedo' of Plato, edited with introduction and notes by H. W. MacMillan and Co.*, London. 1904. Pp. xxxix + 251.
387.

WILPERT Paul. 'Die Elementenlehre des Platon und Demokrit', in *Natur, Geist, Geschichte, Festschrift für Aloys Wenzl*. Filser-Verlag, München-Pasing. 1950. Pp. 49-66.
287 n. 13. 289 n. 17.

WYTTEBACH Daniel. Πλατῶνος Φαῖδων. *Platonis 'Phaedon', explanatus et emendatus prolegomenis et annotatione D. W. Lugduni Batavorum, apud Haakios et Honkoopios*. 1810. Pp. lxxiii + 366.
80 n. 5.

YOLTON John W. 'The ontological status of sense-data in Plato's theory of perception', *Review of metaphysics* 3 (1949-50) 21-58.

I have not considered Yolton's interpretation in more detail in the body of my work, since it seems to me inextricably linked with all sorts of considerations that can have no historical relevance to Plato's text, as Yolton himself half-admits when he writes of one particularly abstruse feature of his reconstruction: 'To see how Plato answers these questions in his theory, or to decide how he would answer them, since he does not consider these questions, it is first necessary to examine his conception of space' (p. 49, my italics). After several pages of intricate discussion: 'Plato, however, was not aware of these problems and consequently did not work out any proposed solution' (p. 55). It can, of course, be useful to work out, for the sake of conceptual clarity, various problems that have not been considered by the author one is studying, but Yolton seems to have made no serious attempt to distinguish Plato's ideas from his own, and the resulting agglomeration of ideas seems to me too unclear to be capable either of use or of refutation.
152 n. 14.

ZANNONI Giuseppe. *Il 'Timeo' di Platone, tradotto da G.Z., con note esegetiche intercalate al testo sì da renderne corrente la lettura*. Tip[ografia] F. Laga, Faenza. 1923. Pp. 173.

I regret that the Byzantine complexities of the Inter-Library Loan scheme have not enabled me to obtain a copy of this item, cited in the *National Union Catalog* NP 0412662. Is it in fact a first edition of the item cited two entries below?

ZANNONI Giuseppe. *Aristotele, 'Il cielo', introduzione, traduzione e note di G.Z.* Tipografia legatoria Mario Ponzio, Pavia. 1936. Pp. 206.

For *De caelo* book four, and for Aristotle's criticisms of Plato, see pp. 181-99 and 'Prefazione', pp. 46-56.
31 n. 1. 100-1. 335-7. 375-6.

ZANNONI Giuseppe. *Platone 'Timeo', traduzione e note di G.Z., 'II edizione interamente rifatta'*. Stab[ilimento] grafico fratelli Lega, Faenza. 1939. Pp. 143.

I regret that this work was not available to me during the preparation of the present volume. It proves however to have been no great loss: the sections concerning weight contain little more than a repetition of other people's errors. Thus like Archer-Hind (p. 82 n. 7 above) Zannoni takes ἐλαφρότατον at *Tim.* 56B1 to mean only 'il più agile'

(p. 53), and so excludes himself from any consideration of Plato's earlier theory of weight. Like Rivaud (p. 323 above), Zannoni takes *Tim.* 62D8-10 to mean that no part of the circumference is *either* different from another *or* is closer to the centre (p. 62: '... nè ha parte veruna di sè stesso diversa da un'altra nè che sia più verso il mezzo di qualsivoglia di quelle contrarie'). Again like Archer-Hind (pp. 18-19 above) Zannoni supposes that the 'cosmic traveller' (*Tim.* 63A2-4) is walking, not around the earth, but around the (inner?) circumference of the heavens (see his note, p. 127). And yet Zannoni is not devoid of all originality. When he comes to Plato's final definition (*Tim.* 63E3-7), Zannoni does succeed in avoiding Taylor's interpretation (*cf.* pp. 45ff. above), although one may well wonder what strange country he has come to instead. He writes, in his note on this passage, p. 128: 'Ricorrendo, per una più facile intelligenza, a un esempio pratico, per un pesce che vive nell'acqua, il "salire" verso un abisso del mare, che è una montagna di acqua per noi capovolta, vuol dire alleggerirsi di elemento aria che lo rende più pesante verso la regione dell'aria; come noi uomini, per salire verso le regioni dell'aria, aggiungiamo al nostro corpo dei gas, che ci rendono maggiormente "tendenti" verso l'atmosfera.' All this is pretty daft; but at the end of the day is Zannoni's confused reminiscence of the myth of the *Phaedo* (108Dff., *cf.* p. 299 above) really any more foolish than Taylor's confused reminiscence of Aristotle and of Theophrastus?

ZELLER Eduard. *Die Philosophie der Griechen, eine Untersuchung über Charakter, Gang und Hauptmomente ihrer Entwicklung*, later *Die Philosophie der Griechen in ihrer geschichtlichen Entwicklung*. 1st edn 1844. Finally in various editions and with 'Drei Teile, jeder Teil in zwei Abteilungen'. I have quoted Teil i Abteilung 2, and Teil ii Abteilung 1. Teil i Abteilung 2 *Vorsokratische Philosophie, zweite Hälfte*. 6th edn by Wilhelm Nestle, 'mit Unterstützung von Franz Lortzing'. O. R. Reisland, Leipzig. 1920. Pp. viii + 783-1460. Teil ii Abteilung 1 *Sokrates und die Sokratiker; Plato und die alte Akademie*. 5th edn. O. R. Reisland, Leipzig. 1922. Pp. xii + 1105.
7 n. 11. 325.

ZELLER E. 'Plato's Mittheilungen über frühere und gleichzeitige Philosophen', *Archiv für Geschichte der Philosophie* 5 (1892) 165-84.
325.

ZELLER E. 'Miscellanea', *Archiv für Geschichte der Philosophie* 5 (1892) 441-8.
7 n. 11. 325.

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The editions specified are intended primarily as justification of the texts I have transcribed, although where it does not significantly alter the sense I have felt free to change punctuation and accentuation, and on occasion to adopt a reading from the *ap-paratus*, without further acknowledgement of the fact.

The English versions of Greek texts are my own. Except when they are specifically introduced as translations, they have been deliberately cast in the form of an expanded translation or paraphrase. This is intended as an economical way of making my interpretation of minor points immediately clear; it means however that these versions must be read as a commentary upon the text, and cannot be used as a substitute for it.

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|-------------|--|
| <i>BT</i> | <i>Bibliotheca Scriptorum Graecorum et Romanorum Teubneriana.</i> |
| <i>Budé</i> | <i>Collection des Universités de France</i> , publiée sous le patronage de l'Association Guillaume Budé. |
| <i>CAG</i> | <i>Commentaria in Aristotelem Graeca</i> , edita consilio et auctoritate Academiae Litterarum Regiae Borussicae. |
| <i>DK</i> | H. Diels, <i>Fragmente der Vorsokratiker</i> , 1st edn 1903; the pagination is unchanged from the 5th edn by W. Kranz, 1934-7. |
| <i>Dox.</i> | H. Diels, <i>Doxographi graeci</i> (Berolini, 1879). |
| <i>GCS</i> | <i>Die Griechischen Christlichen Schriftsteller der ersten Jahrhunderte.</i> |
| <i>OCT</i> | <i>Scriptorum Classicorum Bibliotheca Oxoniensis</i> (Oxford Classical Texts). |

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| iv 19.1 = [Plut.] 902B-C | 142 n. 38. |

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| <i>ibid.</i> , 532.16-19 | 23 n. | 32. |
| <i>ibid.</i> , 532.24-5 | 23 n. | 32. |
| <i>ap.</i> Theophr., <i>Phys. op.</i> fr. 2 | | 326. |

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RÉSUMÉ EN FRANÇAIS

PREMIÈRE PARTIE: PESANTEUR ET MOUVEMENT

Chapitre I

Le haut et le bas: une représentation traditionnelle de l'univers

Deux lieux opposés se partageraient entre eux l'univers: le bas, vers lequel se dirige tout ce qui possède une masse corporelle; le haut, où les corps ne vont que malgré eux. Telle était, selon Platon, l'opinion communément admise à son époque; si Platon s'y oppose dans le *Timée* (62C3 sqq.), Aristote en parlera, au contraire, en des termes plutôt favorables dans son traité *Du ciel*.

Mais ni la faveur de l'un ni l'opposition de l'autre ne vont sans nuances. Il existe, en effet, pour Aristote deux lieux naturels opposés, le haut et le bas, qui correspondent, selon lui, à la périphérie et au centre de l'univers; mais Aristote ne pense pas que tout mouvement vers le haut soit de ce fait involontaire. Platon, au contraire, partage sur ce point l'opinion populaire: aucun corps ne monte vers le haut, à moins que ce mouvement ne lui ait été imposé par une force extérieure. Platon n'admet pas toutefois que le haut et le bas se partagent entre eux l'univers; sur ce point, il s'oppose formellement à la théorie qui deviendra celle de son élève. Le désaccord de Platon et d'Aristote n'en est pas pour autant total; pour l'un et pour l'autre, et contrairement à ce qu'a pu penser, par exemple, Démocrite, le feu et la terre se dirigent spontanément en deux sens opposés, le feu vers la périphérie, la terre vers le centre de l'univers.

En somme, un tissu d'opinions enchevêtrées, et qui ont donné du fil à retordre aux historiens de la pensée. Pour y voir clair, on devra ne pas trop se fier à l'opinion d'Aristote; se targuant du réconfort apporté à sa doctrine par la croyance populaire, il est arrivé à en effacer la filiation platonicienne. Défions-nous également de l'erreur inverse des historiens modernes; pour combler les lacunes (d'expression et de pensée) dans le texte du *Timée*, ceux-ci mettent des idées d'Aristote au compte de Platon, au point d'obscurcir l'originalité du premier et de ruiner la cohérence du second.

Mais une interprétation différente, la nôtre, ne va-t-elle point sembler trop novatrice, trop hardie? Apporte-t-on du nouveau sur un texte cent fois traduit, mille fois commenté? Reprenons le fil du raisonnement dans le texte déjà cité (*Tim.* 62C3-63A6); relisons le commentaire de Cornford, l'un des meilleurs exégètes modernes du *Timée*. A s'en tenir au sens obvie du texte de Platon, l'univers est sphérique et la terre aussi; celui qui fait le tour de la terre appellera donc «haut» et «bas» un seul et même endroit; incohérence, à laquelle on ne saurait échapper, selon Platon, qu'en renonçant à employer le langage populaire et traditionnel pour décrire l'univers sphérique des philosophes et des astronomes. Tout autre est l'exégèse de Cornford: celui qui fait le tour de la terre appellera «bas» la terre qui se trouve sous ses pieds, et «haut» la voûte qu'il voit toujours au-dessus de sa tête. Thèse parfaitement cohérente; c'est d'ailleurs celle d'Aristote. Mais en l'insérant ici, Cornford compromet à son insu le raisonnement de Platon; celui-ci prenait comme point de départ l'incohérence qu'il décelait dans la représentation traditionnelle de l'univers, pour nous obliger à abandonner cette représentation et à en adopter une autre, celle qu'il exposera dans la partie suivante de ce texte (63A6 sqq.).

Chapitre II

Le feu et la terre: la théorie de Platon

Dans la cosmologie du *Timée*, la terre s'est accumulée au centre de l'univers et le feu à la périphérie. En se référant à cette répartition des éléments, Platon propose l'expérience

suivante. Que l'on se transporte par l'imagination à la périphérie de l'univers; si l'on en détache deux quantités inégales de feu, si on les place sur les plateaux d'une balance et si l'on en soulève le fléau, que voit-on? La quantité moindre, la première, cède à la force qu'on lui oppose; elle sera donc «légère» et montera «en haut». La quantité plus grande sera «lourde» et s'inclinera vers «le bas».

Une expérience analogue aboutit, selon Platon, à la même formulation lorsque, situés au centre, nous pesons des quantités inégales de terre. D'où ce paradoxe: les deux termes «en haut» et «en bas», et les deux autres termes «lourd» et «léger», prononcés à la périphérie, s'opposent à ces mêmes termes, prononcés au centre. A la périphérie, en effet, le corps «léger» qui monte «en haut», c'est la quantité qui «s'élève» en direction du centre; au centre, c'est la quantité qui monte vers la périphérie.

Cette théorie paradoxale devrait remplacer, selon Platon, la représentation traditionnelle de l'univers, exposée au début de ce texte (cf. chap. I *supra*). Le «haut» et le «bas» ne se partagent pas entre eux l'univers; c'est bien plutôt le contraire: chacun de ces deux termes, ainsi d'ailleurs que ceux de «lourd» et de «léger», prononcé à la périphérie et au centre de l'univers, s'emploie de façon différente et opposée.

Chapitre III

L'interprétation moderne

Voilà, ramenée à sa simplicité originelle, la théorie du *Timée* dans laquelle Platon réunit les deux notions de pesanteur et de mouvement. Tout autre est la théorie qu'on trouve chez les commentateurs modernes. Lisons, par exemple, le gros volume de Taylor (douze fois plus long que le texte commenté). D'après lui, une quantité plus grande de terre est plus lourde au centre, plus légère à la périphérie; inversement, une quantité plus grande de feu, plus lourde à la périphérie, devient plus légère au centre. Relisons Thomas-Henri Martin (deux volumes, déjà plus que centenaires, dont le commentaire est deux fois plus long que le texte commenté). Martin compare terre et feu; ce dernier serait plus lourd à la périphérie, plus léger au centre.

D'autres exégètes ressassent les mêmes choses; tous se trompent. Platon n'a point comparé dans ce texte des éléments différents (comme le prétendent Martin, puis Taylor), mais des quantités différentes d'un seul et même élément. Qui plus est, et contrairement à ce qu'a pensé Taylor, c'est toujours la quantité plus grande qui est «lourde», et la quantité moindre qui est «légère». La théorie d'un «renversement» de la pesanteur (le corps «lourd» à la périphérie deviendrait «léger» au centre, et *vice versa*) ne se lit nulle part dans le *Timée*. Les exégètes modernes l'y ont introduite, en se fondant sur des idées puisées ailleurs, dans des milieux aristotéliens et péripatéticiens. Qu'un élément, pris en plus grande quantité, puisse devenir plus léger, voilà en effet une innovation d'Aristote, une idée toute à lui, qu'il affirme expressément ne pas avoir rencontrée dans la pensée de ses prédécesseurs.

D'où ce singulier retournement de l'histoire: les idées que les modernes ont glissées dans le texte du *Timée* sont celles-là mêmes qu'ont exploitées Aristote et Théophraste pour réduire à l'incohérence et à l'absurde la théorie exposée dans ce même texte (voir chapp. X sqq. *infra*).

Chapitre IV

Les limites de l'ambigu

Que l'on ne s'imagine surtout pas que nous considérons la pensée du *Timée* comme un système monolithique et sans fissures, dont l'expression serait achevée jusque dans ses derniers détails, au point d'éliminer toute imprécision dans la pensée de l'auteur et d'interdire tout effort critique au lecteur futur.

Aussi une certaine ambiguïté plane-t-elle encore sur la portée exacte de la définition qui achève ce passage (*Tim.* 63E3-7). De tout ce qui précédait, nous dit Platon, il faut tirer ce principe unique: le mouvement d'un corps vers son semblable est un mouvement vers «le bas», et le corps qui se dirige dans cette direction est «lourd»; en revanche, le corps qui

s'éloigne de son semblable est «léger» et monte «en haut». Platon résume ici, à l'évidence, les deux expériences déjà citées: la mesure du feu à la périphérie et celle de la terre au centre. Mais le caractère synthétique de ce «principe unique» ne fait-il pas aussi penser à la situation inverse: une mesure du feu au centre, une mesure de la terre à la périphérie?

Nous admettrions à la rigueur d'élargir en ce sens la portée de la définition, à condition bien sûr de rester fidèle à sa substance. Reprenons, par exemple, la comparaison des deux quantités de terre. Au centre, il est plus difficile de détacher une plus grande quantité; on peut donc imaginer qu'à la périphérie il serait plus difficile d'empêcher son mouvement de retour. Mais le résultat serait le même dans les deux cas: une quantité plus grande reste «lourde»; une quantité moindre, «légère».

Cette extension de la portée de la définition (admissible d'ailleurs seulement à titre d'hypothèse) n'implique pas la doctrine d'Aristote, que Taylor a glissée dans ce texte: Platon ne pense pas que le feu, lorsqu'il se trouve en plus grande quantité, devient plus léger. Pourquoi supposer en effet que, dans ce texte, Platon ait laissé entendre tout le contraire de ce qu'il a dit? Pourquoi prêter à Platon une doctrine qu'Aristote lui reprochera vivement d'avoir ignorée (cf. chap. X *infra*)?

DEUXIÈME PARTIE: PESANTEUR ET QUANTITÉ

Chapitre V

La théorie des corps-triangles

Un passage antérieur du *Timée* (55D sqq.) parle aussi de la pesanteur. Platon y reprend la théorie des quatre éléments, en essayant de lui donner des justifications géométriques. La terre se composerait de cubes, dont les triangles constitutifs sont des demi-carrés. Le feu, l'air et l'eau se composeraient de tétraèdres, d'octaèdres et d'icosaèdres, dont les triangles constitutifs sont des demi-équilatéraux.

Ainsi s'expliquerait, pour Platon, la transformation des éléments. Chaque polyèdre de même type est de dimensions différentes; mais les deux triangles constitutifs admettent une division à l'infini en des triangles de même nature. Les polyèdres peuvent donc se transformer l'un en l'autre, indépendamment de la différence de grandeur, en se décomposant en des triangles constitutifs qui seraient d'une seule et même taille pour les deux sujets en cause. Seul serait exclu le passage d'un demi-carré à un demi-équilatéral, et donc une transformation de la terre en un élément différent.

Ainsi s'expliquerait encore la diversité des corps sensibles. Chaque polyèdre confère au corps qu'il constitue un caractère spécifique correspondant à sa figure et à sa grandeur propres. Le cube est stable; la terre est donc immobile et résistante. L'icosaèdre est instable; l'eau coule, et contourne l'obstacle des pierres et des rochers qui barrent son cours. Dans ce contexte, nous retrouvons la notion de pesanteur. Les faces du tétraèdre sont moins nombreuses que celles des autres polyèdres; le feu est par conséquent le plus léger de tous les éléments.

Une question se pose d'emblée: quel rapport y a-t-il entre cette théorie et celle exposée dans le passage ultérieur du *Timée* (63A6 sqq.; cf. chap. II *supra*)?

Réponse unanime des exégètes modernes: aucun. L'allusion faite à la notion de pesanteur dans la théorie des corps-triangles ne serait qu'une «remarque incidente et accessoire» (la formule de Cherniss est reprise littéralement par Moraux). Elle n'aurait rien à voir avec la théorie exposée ultérieurement par Platon; seul ce second exposé nous livre sa pensée sur la pesanteur.

Cette réponse laissera perplexe le lecteur d'Aristote. Car celui-ci, pour résumer l'enseignement du *Timée*, s'appuie uniquement sur le premier passage et passe entièrement sous silence le second. Aristote se serait-il trompé, là où Taylor et Cherniss voient clair? A moins que ce ne soit le contraire?

Chapitre VI

Les «deux» théories

On trouve «deux» théories de la pesanteur, exposées en deux endroits différents du *Timée*: une première théorie mentionnée lors de l'exposé des corps-triangles (55D sqq.), une seconde, plus détaillée, où convergent les deux notions de pesanteur et de mouvement (63A6 sqq.). En face de cette dualité, deux attitudes, diamétralement opposées: celle des modernes et celle d'Aristote. Les modernes adoptent la seconde théorie, en écartant la première. Aristote fait exactement l'inverse, en s'appuyant sur la première théorie, sans mentionner la seconde.

Cette difficulté n'est pas propre à la question qui nous occupe. La dualité des théories rencontrée dans l'analyse de la pesanteur se retrouve ailleurs: dans le traitement réservé par Platon à d'autres oppositions, chaud/froid, dur/mou, doux/amer. Une explication détaillée de ces propriétés est donnée dans les pages qui précèdent ou suivent de près l'exposé des oppositions lourd/léger, haut/bas. La même explication pourtant, et les mêmes termes, se lisait déjà quelques pages plus haut, dans l'analyse des éléments et des corps qu'ils composent. Les oppositions chaud/froid, dur/mou apparaissent dans l'analyse des métaux et des «eaux» congelées (grêle, glace, neige, frimas). L'opposition doux/amer intervient dans l'analyse du miel et de l'*opos* (un suc acidulé).

A supposer que Platon ait été incohérent en exposant deux théories de la pesanteur, l'a-t-il été encore dans son analyse de la température, de la densité et de la saveur? Pêche-t-il quatre fois de suite par incohérence? Ne doit-on pas plutôt incriminer les exégètes?

Chapitre VII

Les «affections»

Le *Timée* traite de trois sujets: d'abord *l'âme*, à savoir l'âme du monde, les âmes des astres, les âmes humaines; ensuite *le monde sensible*, comprenant les éléments, les corps qu'ils composent, les perceptions que nous en avons; enfin, *le corps humain*, avec sa structure, son fonctionnement, son équilibre, ses défaillances. La dualité des théories remarquée dans l'analyse des «oppositions» est un trait essentiel de la deuxième partie du traité: la description du *monde sensible*. Les polyèdres, avec leur variété de formes et de grandeurs, expliqueraient *d'abord* les actions des corps les uns sur les autres, *ensuite* les perceptions que nous en retirons lorsque les mêmes actions affectent notre corps.

Prenons l'exemple de la chaleur. Les tétraèdres, en raison de l'acuité de leurs sommets et de leurs arêtes, parviennent à décomposer un assemblage d'icosaèdres; aussi le feu fond-il un métal. Les mêmes tétraèdres s'attaquent à notre corps; nous en ressentons les piqures et nous donnons à ce *pathema* le nom de «chaleur».

Si l'on s'achoppe à la dualité de cette théorie, c'est qu'on se fait une idée inexacte des *pathemata*. Les «affections» ne sont pas des «qualités» dont seraient pourvus les corps, indépendamment des actions qu'ils produisent ou qu'ils subissent, comme l'a pensé Taylor en s'inspirant de la doctrine de Whitehead.

Plus délicate est la nuance qui sépare sur ce point la doctrine du *Timée* et celle du *Théétète*, rapprochées un peu trop brutalement par Cornford. Selon l'enseignement du *Théétète*, il ne peut y avoir de «blancheur» qu'au moment même où communient sujet percevant et objet perçu. En revanche, dans le *Timée*, un même nom s'attacherait à nos perceptions (par ex., nous avons «froid»), à l'agent qui les aurait provoquées (la «froideur» du vent ou de la neige), aux rapports qu'entretiennent entre eux des corps qui ne sont pas les nôtres (on parle du «refroidissement» d'un métal). Mais cette théorie «nominaliste» du *Timée* ne contredit pas l'enseignement du *Théétète*, dans la mesure où le *Timée* n'admet d'autre réalité physique que celle des polyèdres, imprimant ou subissant des *pathemata*.

Chapitre VIII

L'unité retrouvée

Notre interprétation permet de restituer leur cohérence aux deux exposés de Platon sur la pesanteur : la théorie des polyèdres du premier exposé sous-tend la théorie du second exposé sur les *pathemata*. Dans le premier exposé (55D sqq.), Platon rapproche les deux notions de pesanteur et de quantité ; le tétraèdre, en raison du nombre limité de ses faces, correspond au feu, le plus léger de tous les éléments. Ce rapprochement justifie l'analyse de nos «affections» dans le second exposé (63A6 sqq.) ; si l'on détache deux quantités inégales de terre quand on se situe au centre, ou bien deux quantités inégales de feu quand on se situe à la périphérie, dans les deux cas, la quantité moindre, la première, cède à la force qu'on lui oppose et sera donc «légère».

Certes, on ne rencontre pas, dans le second exposé, la comparaison d'éléments différents, formulée implicitement dans le premier. L'essentiel s'y trouve tout de même ; un seul principe sous-jacent, celui d'une correspondance entre la pesanteur et la quantité, relie en effet les deux exposés.

TROISIÈME PARTIE: CRITIQUES ET INTERPRÉTATION

Chapitre IX

Aristote et les critiques modernes

Si Platon a une théorie cohérente de la pesanteur présentée en deux volets (*Tim.* 55D sqq., 63A6 sqq.), comment expliquer que les critiques modernes n'aient retenu que le second, alors qu'Aristote semble n'avoir vu que le premier ?

On se souvient de l'exégèse de Martin et de Taylor (chap. III *supra*). Pour ces deux auteurs, un même corps serait tantôt lourd, tantôt léger ; telle est, pour eux, l'explication du second exposé. Dans le premier, au contraire, le corps le plus petit est aussi le plus léger. La conciliation devient impossible entre les deux exposés ; reniant le premier, les exégètes modernes ne retiennent que le second, le plus détaillé (cf. chap. V *supra*).

Pratiquant la même sélection abusive (adoptant le second volet de la théorie, à l'exclusion du premier), on s'en prend alors à Aristote. Celui-ci critique abondamment la doctrine du *Timée*, mais se méprendrait sur elle, puisqu'il s'appuie uniquement sur le premier exposé ; d'où les sévères critiques prodiguées au Stagirite par les exégètes modernes. Ironie de l'histoire : c'est Aristote qui a choisi la meilleure part. Comme nous l'avons montré (chap. VIII *supra*), le rapport de la pesanteur et de la quantité, formulé explicitement dans le premier exposé de Platon, sert de référence de base dans le second.

Mais comment Aristote a-t-il pu passer sous silence tout l'appareil du second exposé : les zones «opposées» de terre et de feu, les deux opérateurs, la comparaison paradoxale de leurs expériences (cf. chap. II *supra*) ?

Pour Aristote, les objets que nous percevons ne sont pas privés des qualités que nous en dégageons ; les *sensibilia* ne sauraient donc se réduire à des «affections», à des *pathemata*. De ce point de vue, Aristote a pu se croire en droit d'éliminer le rôle de l'observateur dans l'analyse des *pathemata* ; il n'aurait retenu, par conséquent, que l'aspect «objectif», commun aux deux volets de la théorie. La «définition du *Timée*» se réduirait donc chez lui à une simple équivalence de la pesanteur et de la quantité : le poids d'un corps se définit par le nombre de ses surfaces.

Chapitre X

La critique par Aristote de Démocrite et de Platon

Formulée ainsi, la théorie de Platon se ramènerait, dans la critique d'Aristote, à celle de Démocrite. Les triangles, comme les atomes d'ailleurs, sont d'une seule et même «natu-

re»; la quantité plus grande est aussi plus lourde. Platon n'a donc pas reconnu, pas plus que Démocrite, la diversité de «natures» dans le cosmos: la «légèreté absolue» du feu, la «lourdeur absolue» de la terre.

Certes, la critique d'Aristote peut paraître choquante, pour ne pas dire malhonnête, lorsque celui-ci objecte à Platon le mouvement du feu, qui s'élève vers la périphérie plus rapidement en plus grande quantité. Pourquoi supposer que Platon, lui, se serait exprimé autrement?

Aristote répondrait: d'après Platon, le feu, quand il se trouve en plus grande quantité, doit monter plus lentement. Que Platon l'ait dit ou non, la conclusion s'impose dès lors que les deux éléments, le feu et la terre, sont composés d'une seule et même matière, à savoir les triangles, lesquels deviennent plus lourds quand ils sont ou plus grands ou plus nombreux. Qui dit «plus lourd», implique un mouvement plus rapide vers le centre et moins rapide vers la périphérie. S'il avait voulu exprimer autre chose, Platon aurait dû admettre que le feu, contrairement à la terre, devient plus léger, quand il se trouve en plus grande quantité.

Ces cheminements du Stagirite paraîtront assez artificieux à bien des lecteurs modernes. La critique reste toutefois intelligible, à moins qu'on ne s'obstine à imputer abusivement à Platon des idées d'Aristote. Que le feu, en plus grande quantité, devienne plus léger, voilà l'idée qu'ont en effet prêtée au Platon du *Timée* les auteurs modernes. Cette démarche présente le double inconvénient, non seulement de rendre incohérente la théorie du *Timée*, mais encore d'enlever toute intelligibilité à la critique qu'en fait Aristote. Comment en effet la critique d'Aristote peut-elle avoir prise sur une (pseudo)-théorie de Platon, construite à l'aide de matériaux empruntés à l'auteur même de la critique?

Chapitres XI-XII

La critique de Platon par Théophraste: première partie

Les premières objections de Théophraste sont un simple décalque de celles d'Aristote. Pour Platon, une quantité plus grande de terre ou de feu serait lourde, une quantité moindre serait légère. Cette définition toutefois ne vaudrait que pour les corps terreux; le feu, au contraire, lorsqu'il est en quantité plus grande, devient plus léger.

Cette critique confond une nouvelle fois les exégètes modernes. Pour Théophraste comme pour Aristote, l'idée d'un élément qui devient plus léger, lorsqu'il se trouve en quantité plus grande, ne s'intègre pas dans la théorie de Platon; elle la renverse.

Mais si la critique de Théophraste reprend fidèlement celle du Stagirite, elle ne s'en fait pas pour autant le simple écho. Aristote, lorsqu'il résume la théorie du *Timée*, ne se réfère explicitement qu'au premier exposé de Platon; Théophraste au contraire, lorsqu'il résume la même théorie dans les pages qui précèdent sa critique, se fonde expressément sur l'exposé ultérieur. Théophraste confirmerait ainsi l'explication que nous avons donnée de la critique d'Aristote (chap. IX *supra*); tout en visant le premier volet de la théorie de Platon, Aristote garde aussi le second présent à l'esprit.

Chapitres XIII-XIV

La critique de Platon par Théophraste: seconde partie

Dans la suite de sa critique, Théophraste s'en prend plus particulièrement au second exposé du *Timée*: aux expériences des deux observateurs, situés l'un au centre, l'autre à la périphérie de l'univers.

Théophraste concède à Platon qu'il serait plus difficile de soulever une plus grande quantité de terre au centre et une plus grande quantité de feu à la périphérie. Mais il n'en irait pas de même, rétorque Théophraste, si l'on essayait de mesurer du feu au centre, et de mesurer de la terre à la périphérie. Dans ces deux circonstances, on aboutirait, selon Théophraste, à des résultats inverses: il serait plus facile de détacher une plus grande quantité de feu au centre, une plus grande quantité de terre à la périphérie. En conséquence, la quantité de terre plus grande sera plus lourde au centre (parce que plus difficile

à détacher), mais deviendra plus légère à la périphérie (parce que plus facile à détacher). Conclusion: un même corps (une quantité plus grande de terre) sera tantôt plus lourd (au centre), tantôt plus léger (à la périphérie).

Cette thèse nous est déjà bien connue; c'est celle-là même qu'ont projetée sur le texte du *Timée* les exégètes modernes (cf. chap. III *supra*). Peuvent-ils donc invoquer Théophraste en leur faveur? Nullement. Théophraste ne vise point ici à résumer la théorie de Platon, mais à la démolir. La thèse en question, dans toute son absurdité, n'est avancée par Théophraste que pour mieux ruiner la théorie de Platon. Si la critique ancienne rejoint ici l'exégèse moderne, ce n'est donc point pour l'étayer, mais bien pour la condamner.

Platon ne fait aucune allusion explicite à une mesure du feu au centre, à une mesure de la terre à la périphérie. Si d'ailleurs, à titre d'hypothèse, on tirait dans ce sens sa théorie (cf. chap. IV *supra*), on aboutirait à une conclusion tout autre que celle de Théophraste. Il est plus difficile, au centre, de détacher une quantité de terre plus grande; il serait tout aussi difficile, à la périphérie, d'empêcher son mouvement de retour; ici et là, c'est donc la quantité plus grande qui est aussi plus lourde.

Si Théophraste, aboutissant à une conclusion contraire à celle que nous venons d'imaginer, renverse paradoxalement la théorie de Platon, c'est qu'il a plaqué sur elle un élément adventice: le rapport de la pesanteur et de la vitesse, tel qu'Aristote l'avait conçu. D'après ce dernier, une quantité de terre plus grande s'approchera plus rapidement du centre, plus lentement de la périphérie. Théophraste en déduit que si la terre, lorsqu'elle se trouve en plus grande quantité, s'approche plus lentement de la périphérie, elle suivra plus rapidement et donc plus facilement la route inverse; aussi pourrait-on la détacher plus facilement de la périphérie. D'où la conclusion: une plus grande quantité de terre, plus lourde au centre, devient plus légère à la périphérie.

En bon compilateur, Taylor a recopié ce texte de Théophraste dans son commentaire du *Timée*. Ce faisant, non seulement il confond, dans l'exposé de Théophraste, la partie exégétique et la partie critique, mais encore, comble de malheur, en prenant la critique pour l'exégèse, il transforme l'histoire des sciences dans l'Académie et le Lycée en un incroyable tohu-bohu. Il prête en effet au maître l'une des idées qu'avait inventées le disciple pour se démarquer de celui-ci: celle d'un élément qui devient plus léger lorsqu'il se trouve en plus grande quantité.

Chapitre XV

Perspectives: pesanteur, quantité, mouvement

Si l'on ne doit pas imputer à Platon des intuitions d'Aristote, on ne s'étonnera pas que Platon ait connu et dépassé la théorie de Démocrite. La notion de pesanteur était grevée, chez les philosophes d'Abdère, d'une certaine ambiguïté. Les atomes de Démocrite, comme les triangles de Platon, ne sont pas en eux-mêmes pourvus des «qualités» qu'ils nous font percevoir. La pesanteur n'entre pas dans cette théorie, car ce n'est pas notre perception qui rend les atomes «lourds» ou «légers». D'autre part, la pesanteur n'en est pas pour autant une propriété indépendante des atomes, car elle est fonction de leur grandeur. Platon a eu le mérite de dissiper cette ambiguïté; dans le *Timée*, le lourd et le léger, comme le chaud et le froid, comme le doux et l'amer, sont des «affections» (*pathemata*).

Cette innovation n'a pourtant pas oblitéré le rapport quantité/pesanteur qui caractérisait la théorie atomiste; Platon l'a retenu en effet, dans le premier exposé du *Timée*, à cette différence près que, chez Platon, la mesure de la quantité est fonction du nombre (des triangles), et non pas fonction de la grandeur (des atomes). D'où l'unité que nous avons pensé restituer à la théorie du *Timée*: le rapport quantité/pesanteur, décelé dans le premier exposé, légitime le rapport pesanteur/mouvement, élaboré dans le second. En bref, c'est le mouvement des éléments qui nous fait percevoir la différence de quantité.

Malheureusement, ces rapprochements entrevus de quantité et de mouvement se soldent par une nouvelle difficulté: l'absence, dans le second exposé, d'une comparaison entre éléments différents (cf. chap. VIII *supra*). Dans la cosmologie du *Timée*, le feu et la

terre se dirigent spontanément en deux sens opposés, le feu vers la périphérie, la terre vers le centre de l'univers. Dans l'exposé sur les *pathemata*, ce mouvement des éléments en deux sens opposés nous fait percevoir la différence de quantité: la portion plus grande de terre ou de feu, en se dirigeant vers son semblable, sera perçue comme «lourde»; la portion moindre, en s'éloignant de son semblable, sera perçue comme «légère». Mais cette différence dans la direction des mouvements ne créera pas à elle seule une relation de pesanteur, indépendamment de la différence de quantité. D'où un appauvrissement, voire une certaine incohérence, dans la théorie: la comparaison du premier exposé du *Timée*, présentant le feu comme le plus léger de tous les éléments, disparaît dans la théorie des *pathemata*.

On voit poindre ici la théorie d'Aristote. Pour ce dernier, ce qui prime, c'est la différence de mouvement, alors que la différence de quantité reste secondaire. La terre en s'approchant du centre, le feu en s'élevant vers la périphérie, manifestent, celle-là une «lourdeur absolue», celui-ci une «légèreté absolue». La différence de quantité n'intervient que pour déterminer, à l'intérieur de la «lourdeur absolue», une différence de «plus lourd»/«moins lourd», et à l'intérieur de la «légèreté absolue», une différence de «plus léger»/«moins léger».

Démocrite et Aristote sont deux points de repères qui aident à comprendre la théorie du *Timée*. On se souvient de la répartition des notions de quantité et de mouvement, à laquelle nous faisons allusion à la fin du premier volume de cet ouvrage (pp. 364-383). D'après un témoignage de Théophraste, ces deux notions de quantité (densité)/mouvement caractérisaient déjà les représentations primitives de la pesanteur; si Démocrite a privilégié la première, et Aristote la seconde, Platon a retenu les deux.

Ainsi s'expliquerait la dualité des théories qui est apparue dans la deuxième partie du *Timée*; elle reflète les deux notions de quantité et de mouvement rappelées par Théophraste. En réunissant les deux notions dans un même concept, Platon s'est montré à la fois héritier et précurseur: héritier, en ce qu'il retient le rapport pesanteur/quantité, que Démocrite avait dégagé des cosmologies du V^{ème} siècle; précurseur, en ce qu'il entrevoit le rapport pesanteur/mouvement, que fera valoir Aristote.

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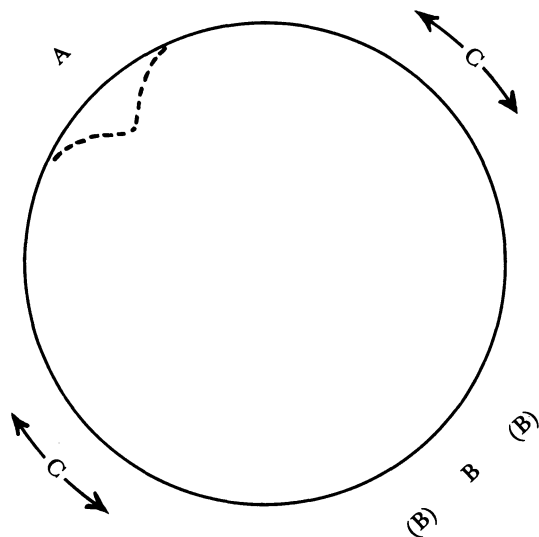
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Timaeus 62D8-10: 'The circumference can hardly be central, nor does it have any one part of itself (A) different from any other (C) in being related to the centre more closely than any one of the parts (B) which are opposite to it.' See above ch. I § 3, pp. 9-15, and Note 1, pp. 319-24.